Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document
FY 2000

A Working Group consisting of:

City of Broomfield
City of Arvada
City of Westminster
City of Northglenn
City of Thornton
Colorado Department of Public Health and Environment
Department of Energy, Rocky Flats Field Office
U.S. Environmental Protection Agency, Region VIII
The Kaiser-Hill Team

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ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

INTEGRATED MONITORING PLAN

September 1999

Responsible Organization: Environmental Management & Compliance

Effective Date:
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Reviewed for
Classification/UCNI:

By ______________

Date ______________

2

Table of Contents

3

4

5

6

7

List of Figures

List of Plates

List of Tables

9

List of Acronyms, Abbreviations, and Measurements

μ	Micro-
μCi	Microcuries
μg	Microgram
μmho	Micromhos
AA	Atomic Absorption
Ag	Silver
ALARA	As Low as Reasonably Achievable
ALF	Action Levels and Standards Framework
Am	Americium
AoI	Analyte of Interest
APCD	Air Pollution Control Division
APEN	Air Pollutant Emission Notice
AQM	Air Quality Management
As	Arsenic
ASI	Advanced Sciences, Inc.
Ba	Barium
Be	Beryllium
BMP	Best Management Practice
BOD	Biological Oxygen Demand
C	Celsius
CAA	Clean Air Act

\\\\

CAB	Citizens Advisory Board
CAPARS	Computer Assisted Protective Action Recommendations System
CAQCC	Colorado Air Quality Control Commission
CAS	Chemical Abstracts Service
CBOD	Carbonaceous Biological Oxygen Demand
CCR	*Code of Colorado Regulations*
Cd	Cadmium
CDPHE	Colorado Department of Public Health and Environment
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cf	Cubic Foot
CFR	*Code of Federal Regulations*
cfs	Cubic Feet Per Second
Ci	Curie(s)
CLP	Contract Laboratory Program
cm	Centimeter
cm^2	Square Centimeter
cm^3	Cubic Centimeter
Co.	County
COD	Chemical Oxygen Demand
ComRad	Community Radiation
Cr	Chromium

CRS	*Colorado Revised Statutes*
Cu	Copper
CWA	Clean Water Act
CWQCC	Colorado Water Quality Control Commission
CY	Calendar Year
D&D	Decontamination and Decommissioning
DEFT	Decision Error Feasibility Trial
DIS	Drain Identification Study
DMR	Discharge Monitoring Report
DNAPL	Dense Nonaqueous Phase Liquid
DOE	Department of Energy
DQO	Data Quality Objective
ECO	Environmental Compliance and Operations
EDE	Effective Dose Equivalent
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
F	Fahrenheit
ft	Feet
ft^3	Cubic Foot
Fe	Iron
FERC	Federal Energy Regulatory Commission
FFCA	Federal Facility Compliance Agreement

FID	Flame Ionization Detector
FIP	Field Implementation Plan
FO	Field Operations
FY	Fiscal Year
g	Gram
gal	Gallon
GC/MS	Gas Chromatography/Mass Spectroscopy
GIS	Geographic Information System
GPMPP	*Groundwater Protection and Monitoring Program Plan*
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
GT	Geotechnical
GW	Groundwater
GWAP	*Groundwater Assessment Plan*
H-3	Tritium
HEPA	High-Efficiency Particulate Air (filter)
Hg	Mercury
hr	Hour
HRR	Historic Release Report
HSL	Hazardous Substances List
HSU	Hydrostratigraphic Unit
IAG	Interagency Agreement
ICP	Inductively Coupled Plasma

ICRP	International Commission on Radiation Protection
IDLH	Imminent Danger to Life and Health
IHSS	Individual Hazardous Substance Site
IM/IRA	Interim Measures/Interim Remedial Actions
IMP	*Integrated Monitoring Plan*
ITS	Interceptor Trench System
IWS	Internal Waste Streams
Kaiser-Hill	Kaiser-Hill Company, L.L.C.
L	Liter
LARS	Laboratory and Radiation Services
LEL	Lower Explosive Limit
LHSU	Lower Hydrostratigraphic Unit
LTL	Lower Tolerance Level
m	Meter
m^3	Cubic Meters
MCL	Maximum Contaminant Level
MDA	Minimum Detectable Activity
mg	Milligram
Mgal	Thousand Gallons
min	Minute
ml	Milliliter
mm	Millimeter

15

Mn	Manganese
mrem	Millirem
msl	Mean Sea Level
N	Nitrogen
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
Ni	Nickel
NO_2	Nitrogen Dioxide, Nitrite
NO_3	Nitrate
Non-PA	Non-Protected Area
NPDES	National Pollutant Discharge Elimination System
NSD	New Source Detection
NSQ	Non-Sufficient Quantity
NVSS	Nonvolatile Suspended Solids
OLF	Old Landfill
OP	Operating Procedure
OU	Operable Unit
P	Phosphorous
PA	Protected Area
PAC	Personnel Access Control
PAM	Proposed Action Memorandum

16

PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
Pb	Lead
PCB	Polychlorinated Biphenyl
PCE	Perchloroethylene
PCOC	Potential Contaminants of Concern
pCi	Picocuries
PID	Photoionization Detector
PM_{10}	Particulate Matter (less than 10 micrometers)
PNNL	Pacific Northwest National Laboratory
POC	Point of Compliance
POE	Point of Evaluation
POps	Pond Operations Plan
POTW	Publicly Owned Treatment Works
ppm	Parts per Million
PPRG	Preliminary Programmatic Remediation Goal
PSL	Process Simulation Laboratory
Pu	Plutonium
PU&D	Property Utilization and Disposal
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPD	Quality Assurance Program Description
QAPP	Quality Assurance Program Plan

17

QC	Quality Control
QCO	Quality Control Objective
RAAMP	Radioactive Ambient Air Monitoring Program
Rad NESHAP	National Emissions Standards for Emissions of Radionuclides Other than Radon from DOE Facilities (40 CFR, 61, Subpart H)
RCRA	Resource Conservation and Recovery Act
RFCA	*Rocky Flats Cleanup Agreement*
RFETS	Rocky Flats Environmental Technology Site
RFFO	Rocky Flats Field Office
RI/FS	Remedial Investigation/Feasibility Study
RMRS	Rocky Mountain Remediation Services, L.L.C.
SAP	Sampling and Analysis Plan
SCMP	Site-Wide Commitments Management Program
Se	Selenium
sec	Second
SEP	Solar Evaporation Pond
SID	South Interceptor Ditch
Site	Rocky Flats Environmental Technology Site
SOP	Standard Operating Procedure
SPCC/BMP	Spill Prevention, Control, and Countermeasures/Best Management Practices
SSC	Species of Special Concern
SVOC	Semivolatile Organic Compound
SW	Surface Water

SWD	Site Soil and Water Database
SWMU	Solid Waste Management Unit
SWWG	Surface Water Working Group
TAL	Target Analyte List
T&E	Threatened and Endangered (Species)
TCA	Trichloroethane
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
tpy	Tons Per Year
TRAC	Terrain Responsive Atmospheric Code
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
U	Uranium
UHSU	Upper Hydrostratigraphic Unit
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTL	Upper Tolerance Level
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WARP	Well Abandonment and Replacement Program
WER	Well Evaluation Report

Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

Introduction

September 1999

21

1.0 INTRODUCTION

The *Integrated Monitoring Plan* (IMP) has been reviewed for fiscal year 2000 in accordance with the Rocky Flats Cleanup Agreement (RFCA) requirements. Revisions have focused on developing more consistent integrated monitoring related to the execution of closure projects, and on providing up-to-date documentation reflecting the most current technical approaches within the routine environmental monitoring programs. The technical changes, though minor, were made mostly in the surface water and groundwater monitoring programs. These changes are seen in the form of newly implemented monitoring locations and a pilot study using a newly available analytical method for isotopic characterization of uranium in groundwater. Integration of project monitoring is discussed more below.

Integration of Site-wide and project-specific monitoring occurs during the planning of all major new activities, such as ER and D&D projects. Kaiser-Hill Company, L.L.C. (Kaiser-Hill) will review all major project plans and evaluate the need for specific environmental monitoring, based on potential release characteristics (e.g., constituents and concentrations), potential impacts [e.g., adherence to regulatory standards, the Rocky Flats Cleanup Agreement (RFCA), and as low as reasonably achievable (ALARA) principles], and existing Site-wide, multi-media monitoring. Consideration will be given to data needs before, during, and after a proposed activity. Monitoring before a project is used to establish baseline conditions, characterize relationships between media, assess potential impacts to multiple media, and develop designs and controls to eliminate or mitigate impacts. Monitoring during and after a project assists in determining the effectiveness and performance of designs and controls to eliminate or mitigate impacts. If additional monitoring is deemed necessary, Kaiser-Hill works with project personnel to develop appropriate, media-specific DQOs and monitoring specifications. Project-specific DQOs will address protection of project personnel, collocated workers, off-Site populations, and the environment, and generally complement Site-wide monitoring DQOs. As projects are planned, project-specific monitoring plans will be included in separate field sampling plans and/or health and safety plans, and, therefore, will be available for review by the regulatory agencies and other stakeholders.

A key component of the DQO process and the RFETS IMP is data evaluation. To be successful, both Site-wide and project-specific monitoring data need to be continuously evaluated to support the DQO decision rules. Decision rules could address baseline definition, relationships between various media, performance and compliance demonstration, and identification of unplanned conditions and trends. Actions based on data evaluation are specified by the decision rules. Actions also may involve modification of DQOs and monitoring specifications. For example, additional data may be required to adequately characterize observed conditions and potential impacts (e.g., exceedance of RFCA Tier I and Tier II groundwater action levels), and in some cases, to properly scope a proposed activity (e.g., ER and D&D projects, or changes to existing water management schemes). Data evaluation is discussed in the media-specific sections that follow and in RFETS environmental program plans.

Data reporting and data exchange were considered during the development of the IMP. The data exchange mechanism, which was formalized as a RFCA requirement (Section 207), will provide Site-wide and project-specific monitoring data to all appropriate monitoring entities and regulatory agencies and will allow these groups to evaluate data needs associated with proposed activities (e.g., baseline characterization, sampling program design, and performance monitoring). Work is progressing on defining the data management tools needed for data exchange and interpretation. All entities are involved to ensure that the proper information is conveyed in a timely manner.

The plan presented herein should be considered dynamic. The monitoring programs will evolve as further progress is made on Site remediation and closure, as new remediation and closure efforts are planned and initiated that require performance monitoring, as the regulatory setting changes, and as new data become available to improve the statistical design. Such changes will be made by the multi-party working group and documented in updates to this plan. Periodic meetings of the working group will be held, and resulting changes will be presented to other stakeholders. Additional work that should be performed is presented below.

- Continue to evaluate groundwater data regarding Tier I and II exceedances, and modify sampling and analysis accordingly (data review, additional sampling and analysis, and modeling as appropriate), for example:
  - Nitrate plume at Solar Ponds,
  - Walnut Creek wells,
  - Wells north of B771/B779 Complex, and
  - Volatile organic compound plume at Property Utilization and Disposal (PU&D) yard;

1.1 Background

Soon after Kaiser-Hill became the Integrating Management Contractor at the RFETS, Kaiser-Hill undertook a structured, comprehensive, reevaluation of all environmental monitoring programs. The objective of this effort was to develop specifications for monitoring utilizing the U.S. Environmental Protection Agency's (EPA's) established DQO process. The process involved the Department of Energy (DOE), EPA and Colorado Department of Public Health and Environment (CDPHE) (state) regulators, the cities of Broomfield and Westminster, and the Kaiser-Hill team. The effort was intended to identify any unnecessary monitoring and assess for improvement in the monitoring programs, and to ensure protective and compliant programs. Using the consensus specifications (DQOs), an optimal data collection design was determined. This approach demonstrates compliance with the myriad of federal and state regulations and DOE Orders, and supports the decisions that must be made to protect human health and the environment with an

24

specifications (DQOs), an optimal data collection design was determined. This approach demonstrates compliance with the myriad of federal and state regulations and DOE Orders, and supports the decisions that must be made to protect human health and the environment with an acceptable degree of certainty. The monitoring programs of the regulators and cities were included and also modified to develop an integrated, multi-party Site monitoring program. The development and maintenance of this integrated program became a requirement of the RFCA issued on July 19, 1996[1]. The *Integrated Monitoring Plan* is a result of the process described above.

The DQO process is a structured decision-making process that requires the identification of and agreement on decisions for which data are required, and results in the full set of specifications needed to develop a protective and compliant monitoring program (i.e., qualitative and quantitative statements that specify the type, quality, and quantity of the data required to support decision making). The formal DQO process is documented in two EPA documents (EPA,1993a; EPA, 1993b). In September 1994, DOE institutionalized the DQO process for environmental data collection activities. This was implemented to balance DOE's environmental sampling and analysis costs with the need for sound environmental data that address regulatory requirements and stakeholder's concerns. Specific steps in the DQO process include:

- Identify and define problem(s) to be solved;
- Identify decision(s) to be made relative to the problem;
- Identify inputs to the decision (data needed to make decision);
- Define study boundaries/scope of problem and decision;
- Develop decision rule(s) [IF/THEN action statement(s)];
- Specify limits on decision errors (acceptable types and degrees of uncertainty); and
- Develop and optimize design for obtaining data.

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[1] RFCA Part 21 Sections 267 and 268 state: "In consultation with CDPHE and EPA, DOE shall establish an IMP that effectively collects and reports the data required to ensure the protection of human health and the environment consistent with the Preamble, compliance with this Agreement, laws and regulation, and the effective management of RFETS's resources. The IMP will be jointly evaluated for adequacy on an annual basis, based on previous monitoring results, changed conditions, planned activities and public input. Changes to the IMP will be made with the approval of EPA and CDPHE. Disagreements regarding any modifications to the IMP will be subject to the dispute resolution process described in Subpart 15B or E, as appropriate."

"All Parties shall make available to each other and the public results of sampling, tests, or other data with respect to the implementation of this Agreement as specified in the IMP or appropriate sampling and analysis plan. If quality assurance is not completed within the time frames specified in the IMP or appropriate sampling and analysis plan, raw data or results shall be submitted upon the request of EPA or CDPHE. In addition, quality assured data or results shall be submitted as soon as they become available."

The goal of using this approach was to reevaluate the basis and focus of existing programs, increase the defensibility of Site monitoring, and incorporate regulatory changes (e.g., water quality standards and cleanup levels) associated with RFCA. The RFCA requirements have been incorporated into the DQOs.

Implementation of the DQO process forces data suppliers and data users to consider the following questions:

- What decision has to be made?
- What type and quality of data are required to support the decision?
- Why are new data needed for the decision?
- How will new data be used to make the decision?

DOE and Kaiser-Hill recognized that the Site could no longer have separate, non-integrated sampling and analysis activities performed by various entities at the Site (e.g., Environmental Restoration and Environmental Protection), or between the Site, the cities, CDPHE, and EPA Region VIII. DOE and Kaiser-Hill also realized that they should not work alone; therefore, an integrated monitoring working group was formed with representatives from DOE, K-H Team, EPA, CDPHE, and the cities of Broomfield, Northglenn, Arvada, and Westminster to develop consensus on what data were needed and how data would be used, and to develop sampling and analysis plans based on these specifications. The responsibility for data generation was then spread across these entities in a logical way. In developing the requirements for an integrated monitoring plan, the decisions and multimedia data requirements associated with the Rocky Flats Cleanup Agreement (RFCA), Resource Conservation and Recovery Act (RCRA); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); the Clean Air Act (CAA); the Clean Water Act (CWA); the Colorado Water Quality Control Commission (CWQCC) standards; natural resource management regulations, Site-specific cleanup agreements (e.g., the *Industrial Area Interim Measures/Interim Remedial Action Decision Document*), and several DOE Orders were considered. After data requirements to support each of the desired decisions were identified, data collection was streamlined by looking for opportunities to use measurements for more than one decision.

To accomplish the work associated with developing an integrated monitoring plan, four medium-specific DQO working groups (i.e., surface water, groundwater, air, and ecological resources) were established. Each group met regularly to work through the DQO process for each decision that required monitoring data. In addition, all four groups met together to discuss data needs across media, share progress, ensure consistency, and identify problems. DQO facilitators and statisticians, sponsored in part by DOE Headquarters, assisted the integrated monitoring working group in developing the DQOs, evaluating the adequacy of existing designs, and developing new sampling and analysis plans. The results of these efforts represent a multi-party consensus agreement and are documented in this document by environmental media. Integration was

24

achieved between monitoring entities, regulatory programs, and environmental media. Interactions between media are discussed in Section 7.0 of this *IMP Background Document*.

This document covers all the environmental monitoring conducted by DOE and the Kaiser-Hill team, as well as monitoring conducted by CDPHE and the cities where interface and integration opportunities exist. Other monitoring conducted by CDPHE and the cities is related to the Site, but does not present integration opportunities (e.g., monitoring of area reservoirs conducted by the cities and spot checks conducted by CDPHE).

1.2 References

U.S. Department of Energy, Colorado Department of Health and Environment, and U.S. Environmental Protection Agency, 1996. *Final Rocky Flats Cleanup Agreement*, July.

U.S. Environmental Protection Agency, 1993a. *Guidance for Planning for Data Collection in Support of Environmental Decision Making Using the Data Quality Objective Process,* EPA QA/G4.

U.S. Environmental Protection Agency, 1993b. *Data Quality Objectives Process for Superfund,* EPA/540/G-93/071.

Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

Surface Water Monitoring

September 1999

28

Table of Contents

29

List of Figures

List of Tables

30

List of Tables Continued

31

2.0 SURFACE WATER MONITORING

2.1 Introduction

In accordance with the objectives stated in the Preamble to the Rocky Flats Cleanup Agreement (RFCA), the Rocky Flats Environmental Technology Site (RFETS or the Site) operates a robust surface water monitoring system to provide information for cleaning up the Site, to assure public safety, and to keep the public informed. This chapter of the *Integrated Monitoring Plan* (IMP) *Background Document* describes the specific surface water monitoring objectives implemented to achieve this goal for fiscal year 2000 (FY00).

Surface water is defined here as water flowing above ground in natural or manmade channels, water detained in Site detention ponds or other natural or manmade depressions which require dewatering, or water processed through the Site sanitary system. Site surface water may originate as rainfall on-site, surface water from up-gradient sources, water purchased from the Denver Water Board (DWB) for domestic use on-site, or groundwater discharge to the surface via seeps or footing drain discharge.

2.1.1 Summary of Monitoring Objectives

This chapter describes surface water monitoring objectives to be implemented for fiscal year 2000. The monitoring described herein integrates all surface water monitoring activities across the Rocky Flats Environmental Technology Site (RFETS or the Site) (see Figure 2-1), which are performed under RFCA, including much of the Site monitoring performed by the cities and the state.

The Data Quality Objective (DQO) process was used to determine decisions of necessary and sufficient monitoring requirements. The process yielded over 20 data-driven decisions, requiring various levels of priority and confidence.

In this document, surface water monitoring objectives (a.k.a. "decision rules" under the DQO process) are organized in a roughly upstream-to-downstream order, beginning with process discharges within the Industrial Area (IA) and ending at the drinking water reservoirs downstream. This order is depicted in Figure 2-2. These monitoring objectives are summarized in the following paragraphs and are discussed in detail in the remainder of this section.

To begin, monitoring objectives that do not fit into the upstream-to-downstream sequence are discussed in Section 2.2 as Site-Wide Monitoring Objectives. The first of these objectives is monitoring to ensure safe operation of the dams. Safety monitoring to avoid dam breaching is discussed first (Section 2.2.1), in recognition of its unique importance to avoiding imminent danger to life and health (IDLH). Another monitoring objective, Source Location monitoring, designed to locate a source of contamination detected by other monitoring objectives, is also covered under Site-Wide Monitoring Objectives in Section 2.2.2. Because Source Location of a contaminant source could take place anywhere in the area shown in Figure 2-2, it does not fall into the upstream-to-downstream order. Further, some monitoring needs simply cannot be known in advance. These are discussed as Ad Hoc monitoring (Section 2.2.3). Finally, monitoring may be performed to evaluate management alternatives such as controlled detention[1] pond management. Specifically, in this document, this refers to monitoring for correlation of Plutonium to TSS in surface water, as discussed in Section 2.2.4.

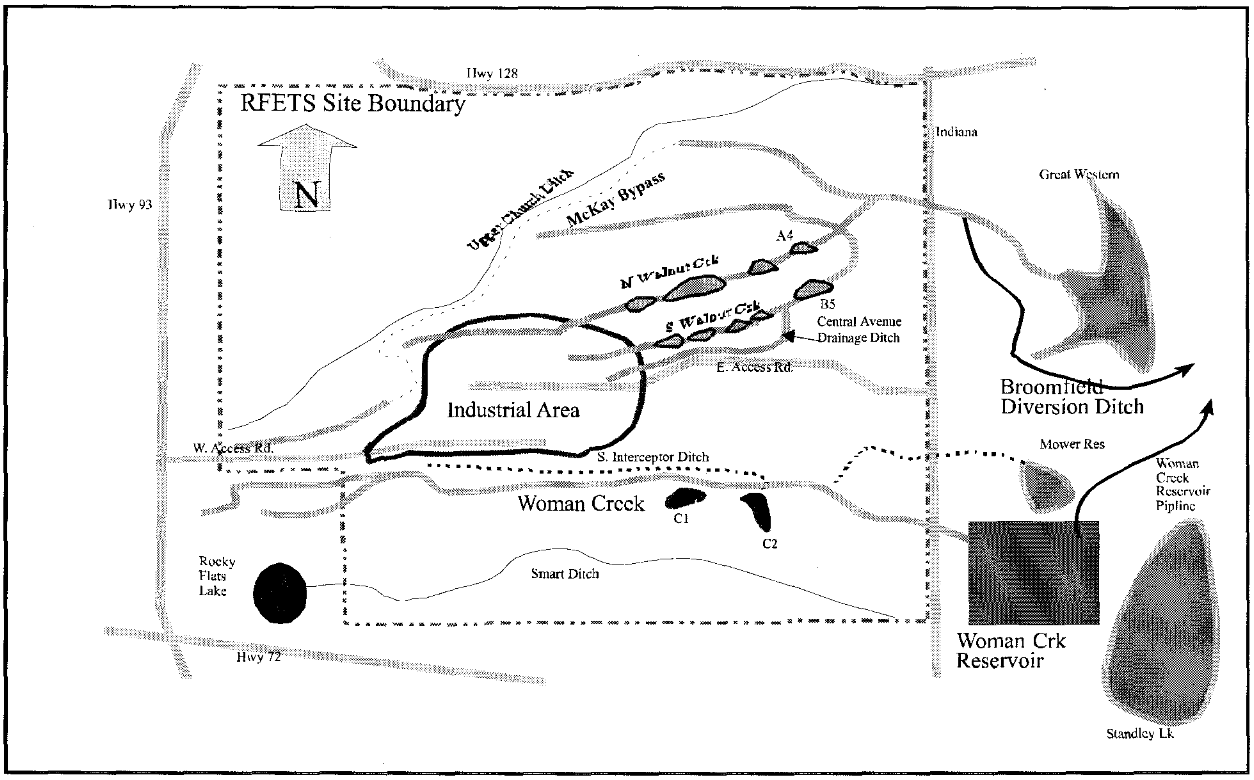

Figure 2-1. Conceptual Sketch of Major Site Surface Water Features.

The first of the upstream-to-downstream monitoring objectives is Industrial Area Monitoring. RFCA and the Industrial Area Interim Measures/Interim Remedial Action (IM/IRA) Decision Document (DOE 1994) require the Site to characterize significant surface-water releases within the Industrial Area. Immediately outside the buildings of the IA, the Site must often decide whether incidental waters (see Section 2.3.1) that accumulate in berms, utility pits, etc, must be treated, or whether they can be discharged directly to the environment or to the sanitary system. Discharges to the sanitary system, both routine and non-routine, are also monitored as discussed in Section 2.3.2. Internal waste streams are discussed in Section 2.3.2.1. To develop the National Pollutant Discharge Elimination System (NPDES) permit application, the Site monitored the internal waste streams of some processes within facilities to establish what the Site might reasonably expect to see in discharges from these processes. Additionally, the Site is routinely required to determine whether some internal waste streams (Section 2.3.2.1) may be discharged from the IA to the WWTP. In addition, NPDES monitoring must be performed on the WWTP discharge to the ponds.

[1] Controlled detention is a strategy for Site pond operations that would allow continuous discharge of water from the terminal ponds under carefully controlled conditions.

33

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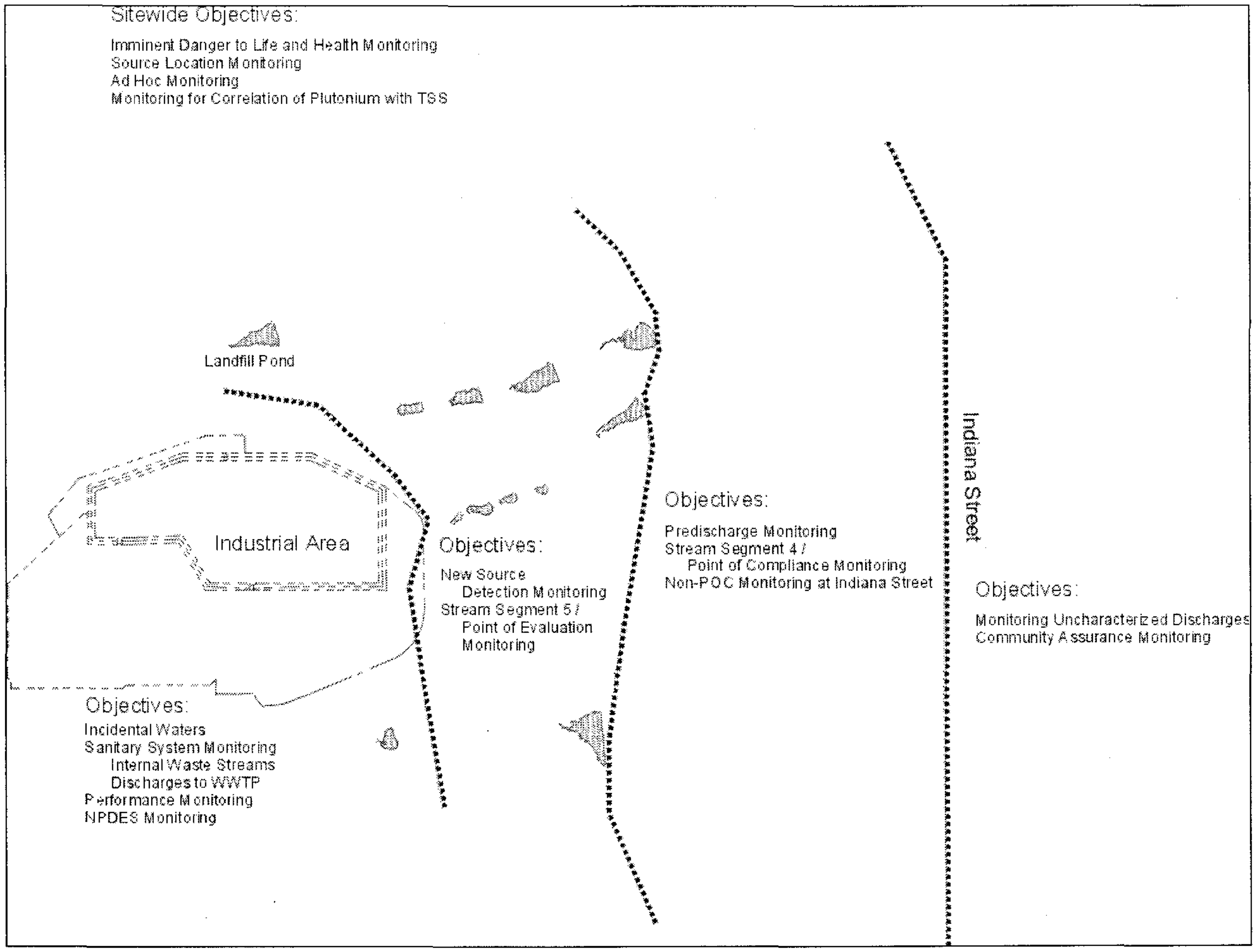


Figure 2-2. Conceptual Model of Site Monitoring Objectives.

Individual high-risk projects (generally located within the IA) will sometimes warrant Performance Monitoring (Section 2.3.3) to detect a spill or release of contaminants specifically from that project. The Site must also monitor specific point-source discharges as specified by the NPDES permit (Section 2.3.4).

The next of the upstream-to-downstream monitoring objectives (Section 2.4) deals with discharges from the IA to the ponds. RFCA and the Industrial Area Interim Measures/Interim Remedial Action (IM/IRA) Decision Document require the Site to identify and correct significant accidental or undetected releases of contaminants from the IA to the Site Detention Ponds (surface water leaving the IA and entering Segment 5). To decide whether a significant release of contaminants has occurred, the Site performs New Source Detection (NSD) monitoring of IA runoff for significant increases in contaminants (see Section 2.4.1). Additionally, the RFCA specifies monitoring for the upstream reaches of Site drainages (above the ponds) and specifies action levels for contaminants (Action Level Framework). This Stream Segment 5 / Point of Evaluation (POE) monitoring is addressed in Section 2.4.2.

Continuing downstream with the monitoring objectives, terminal detention pond discharges and surface water leaving the Site are monitored. Predischarge monitoring of terminal Ponds occurs prior to controlled discharges (Section 2.5.1). The Site also monitors at Points of Compliance

(POCs) below the terminal ponds to demonstrate that the Site discharge meets state stream standards in Segment 4 (Section 2.5.2), as specified in RFCA. Further, there are RFCA POCs on Walnut and Woman Creeks that are monitored at the Site boundary and Indiana Street (Section 2.5.2).

The State of Colorado and downstream communities are concerned that the water quality in downstream reservoirs might be degraded by Site discharges. Section 2.6 addresses off-Site monitoring objectives. These data are used to make decisions regarding potential use of the water for drinking and irrigation and for compensatory actions such as providing alternate water sources and reservoirs.

Section 7.0 of this *IMP Background Document* addresses the interfaces between surface water and other media: soil, groundwater, air, and ecology. For example, contaminants in groundwater and soil could conceivably contaminate surface water, and surface water could subsequently adversely affect habitats of endangered species. Monitoring objectives to evaluate the interaction between the media are addressed in the Groundwater Monitoring Section 3.0.

2.1.2 Geologic and Hydrologic Setting

This section is included only as an introduction to the Site for members of the public not already familiar with the Site. This section contains no monitoring requirements or other commitments or agreements between the parties. Nor does this section contain material that affects the interpretation of the rest of the document.

Geographically, the Site surface waters are bounded:

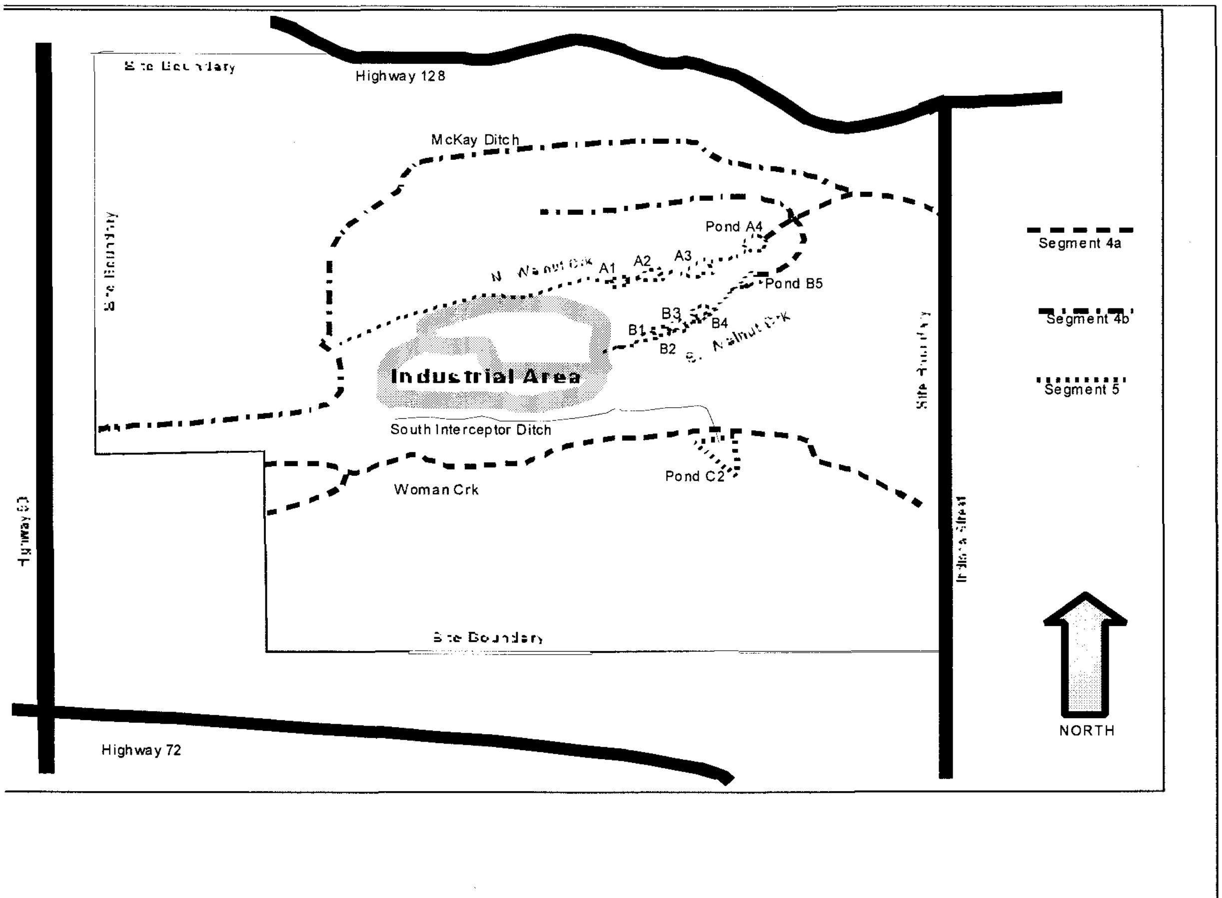
- Upstream by the West Interceptor Ditch (McKay Bypass);
- On the south, by the South Interceptor Ditch (SID) or by Woman Creek, subject to discussion and context;
- On the north by the landfill drainage; and
- On the downstream end by Great Western Reservoir and Standley Lake or by Stream Segment 1 of Big Dry Creek, subject to discussion and context.

These features are shown in Figure 2-1 and Figure 2-2. A detailed discussion of Site geology and hydrology is presented in Appendix C to Section 3 of this *IMP Background Document.*

The stream drainages leading off-Site are Walnut Creek, Woman Creek, and Rock Creek. The figures illustrate the first two drainages and their tributaries. North Walnut Creek and South Walnut Creek flow through the A- and B- series ponds, respectively. The Colorado Water Quality Control Commission (CWQCC) has designated the portion of these drainages from Ponds A-4 and B-5 to Indiana Street as Stream Segment (Segment) 4b. Tributaries to the A and B terminal ponds, and Pond C-2 itself, are designated as Stream Segment (Segment) 5. The South Interceptor Ditch and Ponds A-1, A-2, B-1, and B-2 have not been designated as waters of the state. These stream segment designations are best illustrated in Figure 2-3.

35

Figure 2-3. Sketch of Stream Segments 4a, 4b, and 5



2.1.1. Assumptions

The Surface Water IMP Working Group made some assumptions in order to focus the monitoring program on practical concerns. These assumptions acknowledge that monitoring for all possible Site conditions, contaminants, and practices, would be an inefficient use of limited resources. The Working Group's planning assumptions are presented below. These assumptions may not continue to be true in the future in all cases, and this document does not constitute agreement between the parties that these assumptions will be maintained. However, if an assumption becomes invalid during the effective period of this plan, then some of the monitoring that was excluded on the basis of that assumption should be reconsidered and possibly implemented in future years.

- Deviation from these assumptions requires prior approval of the U.S. Environmental Protection Agency (EPA), Colorado Department of Public Health and Environment (CDPHE), and the Department of Energy (DOE), as required in RFCA Part 23, paragraph 267.

36

- Monitoring objectives specified herein will be implemented by the parties, subject to funding constraints and priorities, as specified in RFCA Part 11, Subpart A.

- This plan incorporates all surface water monitoring of Site discharges to surface water and contaminant impacts down to and including Broomfield and Westminster water supplies. Monitoring and decisions by the Site, the State of Colorado, and the cities are included.

- Decisions regarding IDLH are deserving of special attention and will be segregated from decisions regarding likely low-risk health concerns to ensure that no confusion will arise regarding the priority of IDLH decisions over strictly water-quality decisions.

- The parties agree that continuous water-quality monitoring probes will be used as indicators that may suggest a need for additional monitoring, mitigating action, or management decision. The parties agree that compliance and enforcement issues will be resolved on the basis of standard analytical procedures specified by the applicable regulation or agreement, e.g., NPDES, RFCA, or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The parties agree that continuous monitoring field probes should NOT be used to determine compliance or serve as a basis for enforcement action, unless the applicable regulation specifies such a probe as the enforceable analytical method for a particular measurement.

- For purposes of computation in regulatory reporting, the sample date for a multi-day composite sample will be the date that the sample was started. Although this will give the impression that multi-week samples are being reported months late, this convention is consistent with all other Site data.

- Termination for Cause: Successful completion of a flow-paced composite sample is determined by several factors that are evaluated by the sampling team. These include, but are not limited to, the required sample volume for analysis [normally $\geq$ 4 liters (L)], weather conditions, equipment failures, work schedules, sample preservation, potential loss of data, regulatory reporting schedules, Site exercises, and other concerns.

- Non-Sufficient Quantity (NSQ): If sample accumulation is terminated for cause, and sample volume is inadequate for routine lab analyses, then no analyses are required, and the sample will not be used in the computation of a 30-day moving average. For example, routine lab analysis for plutonium (Pu) and americium (Am) require 4.12L. Therefore, samples of less than 4.12L may be discarded and not used in the computation and evaluation of compliance parameters, but must be reported. This requirement may be referred to as the NSQ requirement regarding insufficient quantity of sample.

37

- The 30-day moving averages will be computed twice each month within 5 working days of the 15th day and the last day of the month for sample results received between these dates and reported per the RFCA ALF.

- Where there is no significant flow, there may be no samples completed within a 30-day period. However, flow-paced sampling will continue during dry periods, even though flows may be so low that it may take longer than 30 days to fill the sample carboy.

- If no samples are taken during a 30-day interval due to a no-flow condition, then no sample result will be available for use in the computation of a 30-day moving average, and no such average will be reported for that period.

- All samples taken for RFCA monitoring under this plan must be reported, even if they are not analyzed, and the reason for not analyzing (e.g., NSQ) must be reported.

- All monitoring data acquired under the same procedural controls as used for RFCA monitoring are actionable[2] under RFCA and applicable regulations, even though it may not have been specifically identified as an analyte of interest (AoI) in Tables A-26 and A-27 in Appendix A to this section.

- Many areas of the Site are linked by the flow of water within and above the ground surface in an upstream-to-downstream direction. Contaminants monitored in one area may have originated in an upstream area.

- These monitoring objectives are based on requirements set forth in federal and state regulations, with authority derived, respectively, from the federal Clean Water Act and the Colorado Water Quality Control Act.

- Each monitoring objective that requires comparison to baseline presupposes establishment of baseline will be performed before decisions are made on the basis of the data. Each monitoring objective that specifies decisions based on statistical tests assumes that variability of data will be established before decisions are made on the basis of the data.

2.1.4 Outstanding Issues

- As of this revision, the NPDES permit has not been re-issued. When the new permit is approved, the IMP Surface Water Working Group (SWWG) will review permit requirements for impacts on monitoring.

[2] The term "enforceable" has been reserved for Segment 4 standards, as opposed to Segment 5 action levels. The term "actionable" is intended here to include enforcement actions, actions taken in response to action level exceedances, and any other action required under RFCA in response to monitoring data.

- The Site operators request to change pond operations protocol from batch discharge to controlled detention for off-Site release of surface waters and related impacts on monitoring are also unresolved.
- Terminal ponds will continue to be operated in a batch mode to the extent practicable throughout FY99and FY00.
- A detailed summary of ongoing Industrial Area decontamination and decommissioning (D&D) monitoring is not part of the IMP or the *IMP Background Document*. This information should be reported in an annual summary to accompany the IMP and the *IMP Background Document*. This summary should include a review of performance monitoring and any monitoring of routine sanitary waste streams.

2.1.5 Quality Assurance

Sampling and analysis of Site surface water is controlled by Standard Operating Procedures, the RMRS *Quality Assurance Program Plan*, the *Site Quality Assurance Manual*, and Analytical Services' *Statement of Work for Analytical Measurements, General Laboratory Requirements.* The *Statement of Work for Analytical Measurements, General Laboratory Requirements* presents the approved analytical methods, hold times, detection limits, and laboratory data reporting protocol. Sample sizes (number of independent samples analyzed) for FY99 were determined by the NPDES permit in some cases and by desired confidence intervals, subject to funding limitations, in other cases. For additional details, such as requirements for blanks and duplicate samples, refer to the following plans and procedures.

- *Statement of Work for Analytical Measurements, General Laboratory Requirements, Module GR01-A.* Kaiser-Hill Company, L.L.C., Golden, Colorado, December 10, 1996.
- *Site Quality Assurance Manual, Rocky Flats Plant.* Rocky Flats Environmental Technology Site, Golden, Colorado, 1996.
- *Quality Assurance Program Plan. Manual No. 95-QAPP-001, Rev. 0, 10/4/95.* Rocky Mountain Remediation Services, L.L.C., Golden, Colorado, 1995.
- *EMD Operating Procedures Volume I, Field Operations, Manual No. 5-21000-OPS-FO.* EG&G Rocky Flats, Inc., Rocky Flats Plant, Golden, Colorado, 1992.
- *EMD Operating Procedures Volume IV, Surface Water, Manual No. 5-21000-OPS-SW.* EG&G Rocky Flats, Inc., Rocky Flats Plant, Golden, Colorado, 1992.

2.1.6 Reporting

Data specified in the surface-water monitoring objectives are used in decision making. Many of the data are not routinely reported to parties other than to the decision maker(s) for a particular decision. These data are managed in the Site Soil and Water Database (SWD) or other Site databases for subsequent queries. (Secondary data usage is quite common.) Some typical (though non-inclusive) examples of data usage are described below.

- IDLH data are used to make management and operational decisions, for example to determine when valves and flood gates should be opened and closed. Some of these data may be reported verbally to the DOE, Rocky Flats Field Office (RFFO) and regulators during the decision-making process, but no formal report of pond levels, valve positions, and piezometer readings is produced as a separate or special regulatory report.
- If data helped to locate a new contaminant source, then the source and data would be reported for appropriate management action.
- *Ad hoc* monitoring requested by on-Site parties is reported to the requestor.
- The results of monitoring for correlation of Pu with particulates could be published in a letter report, at the discretion of the Site.
- The NSD monitoring would be reported internally to initiate evaluation if a new contaminant source were detected, but no public or regulatory report would be routinely produced.
- The disposition of internal waste streams and incidental waters is based on data-driven decisions. The data are recorded and reported to the decision maker, with an annual summary of routine internal waste streams provided to the EPA.

There are a few routine reports prepared for surface water data. Current reports are:

- NPDES monitoring data are reported in a *Discharge Monitoring Report* (DMR) each month to EPA;
- CDPHE routinely reports predischarge and community-assurance monitoring results to the Site and cities;
- Monitoring results above RFCA standards and action levels are reported to both EPA and CDPHE; and
- Many of the surface water data are summarized and reported at the Quarterly Information Exchange Meetings.

2.2 Site-Wide Monitoring Objectives

The monitoring objectives in this IMP are generally presented in an upstream-to-downstream order. This section addresses monitoring objectives that cannot be ordered in that way. This section also addresses cross-cutting monitoring objectives such as: safe operation of the dams (Section 2.2.1), location of contaminant sources, wherever they may occur (Section 2.2.2), special request (*ad hoc*) monitoring (Section 2.2.3), and the use of operational indicators of Pu levels to describe actinide transport and to design and implement pond operations (Section 2.2.4). None of this monitoring is confined to a single geographical area of the Site. Figure 2-4 shows the locations of specific monitoring locations referenced under each objective. In the interest of fiscal and operational efficiency, many of these locations collect data to support multiple monitoring objectives. The location code in Figure 2-4 are those used in the Site's Soil and Water Database (SWD).

2.2.1 Imminent Danger to Life and Health (IDLH) Decision Monitoring

This IDLH section uses the term "action level" in reference to dam operations. This is an entirely different usage unrelated to the RFCA Action Levels and Standards Framework (ALF) discussed elsewhere in this document.

The Site has a network of detention ponds with earthen dams (Figure 2-4). Failure of an earthen dam would present an Imminent Danger to Life and Health. Safety and health professionals often refer to such conditions as Imminently Dangerous to Life and Health conditions. The Site has several ponds formed by dams that can hold a limited amount of water safely. Water may be discharged from these ponds through the outlet works or by pumping. Water does not normally overtop the dams, which are all of earthen construction and would be damaged and could fail under those conditions. Heavy rain or snow melt can challenge the capacity of the ponds faster than the ponds can be predischarge monitored and subsequently batch discharged.

Problem Statement:

> If water levels rise above safety limits that preserve dam integrity, then ponds must be discharged to prevent overflow or breaching.[3] The risk to the public and environment is far greater from a dam breach than from the normally low levels of contaminants that might be found in pond waters.

Problem Scope:

> The actual decision process for managing pond operations and conducting pond and dam monitoring activities is too complex to be treated in this document. Detailed information can be found in the *Pond Operations Plan* (POP)(Kaiser-Hill et al., 1996), and the *Action Level Response Plan for Dams A-4, B-5, or C-2* (RMRS, 1995). The following *generalized decisions* must be made on a continuous basis for Pond A-4.

[4] Maximum discharge rate for earthen dams is one foot per day to achieve drawdown without inducing sloughing of the saturated sides of the dam.

Similar decisions are made for Ponds A-3, B-5, and C-2. A series of simultaneous equations are solved via an expert system framework to consider actions associated with modeled action levels.

Information Types and Frequency:

The decision factors include safe pond capacity, actual pond elevation, current and projected flow rates into and out of the ponds, and several indicators of dam integrity, such as piezometer readings, inclinometer readings, and cracks or sloughs of embankment material. The information needs are as follows:

- Pond inflow rates into Ponds A-3, A-4, B-5, and C-2 (must be continuously monitored for daily to hourly averages with instantaneous measurement capability)[4]
- Pond elevation for Ponds A-3, A-4, B-5, and C-2 (must be continuously monitored for daily to hourly averages with instantaneous measurement capability)
- Measurements from piezometers in dams (indication of water pore pressure in dam structures)
- Daily to hourly visual inspections of dam integrity
- Results from the expert system that rates the above inputs to determine whether to release water from a dam despite water-quality [Note: *Pond Operations Plan* (Kaiser-Hill et al., 1996) details decision tree that describes this logic]
- Pond discharge rates (pumped or through outlets; daily to hourly averages with instantaneous measurement capability)
- Weather prediction (affects the weighting factors in the expert system)
- Biannual dam inspections
- Annual Federal Energy Regulatory Commission (FERC) inspection
- Crest monument movement monitoring [required by *Code of Colorado Regulations* (CCR) for dams]
- Inclinometer monitoring (required by CCR for dams)

[4] Critical measurements, such as pond inflow rates and elevations, require hourly monitoring capability, even though daily monitoring may be adequate for a portion of the year. For example, during FY 1996, hourly monitoring was actually used for 85 days during the year.

Boundaries:

Spatial: Flow in streams upgradient to Ponds A-3, A-4, B-5, and C-2 is used in decision making. Each individual dam and the water volumes in each pond are included in decision making. Only terminal pond dams that are normally operated to release water off-Site are A-4, B-5, and C-2 in the North Walnut Creek, South Walnut Creek, and Woman Creek drainages, respectively. (Woman Creek normally flows around Pond C-2, through an artificial diversion. However, Pond C-2 is directly in the natural drainage of Woman Creek and may receive overflow from Woman Creek during extreme flood conditions.) Pond A-3 may also be included in this list as a terminal pond under some conditions, such as during upgrade activities in Pond A-4.

Temporal: Information is collected at varying intervals based on the pond conditions and rate of change of the specific parameter. Daily or more frequent dam piezometer data, hourly inflow and outflow data, and hourly to daily pond level data are all transmitted by telemetry. Most decisions are made Monday through Friday on a daily basis; however, during a crisis situation, hourly decisions may be made seven days a week. The Site also maintains instantaneous measurement capability for all telemetry data.

Decision Statements:

IF Water-quality analytical results meet all applicable standards to protect downstream water users, and dam is at pond operations Action Level 3 or less [determined by piezometer readings (water level in dam structure), dam inspections, pool level, and inflow data]—

THEN The Site will discharge water from the pond.

IF A pond reaches Action Level 4 (i.e., exceeds its safe capacity based on data including piezometer readings, dam inspections, pool level, and inflow data)—

THEN The Site will release water (without waiting for analytical results) from the pond at a drawdown rate of one foot per day and notify the Colorado State Engineer and other specified agencies.

IF A pond reaches Action Level 5 [spillway overflow occurring or overtopping expected and/or breaching possible based on data including piezometer and inclinometer (measures the change in a slope, providing early warning of a potential dam failure) readings, dam inspections, pool level, inflow data]—

THEN — The Site will release water (without waiting for analytical results) from the pond at a drawdown rate of 2 feet per day. Notifications to Colorado State Engineer and other agencies are required.

IF — Routine or emergency dam inspections, inclinometer readings, piezometer readings, and/or other monitoring activities reveal changed conditions affecting the structural integrity of a dam—

THEN — The Site will notify the Colorado State Engineer and other agencies, as required by the CCR (2 CCR 402-1, Rules 14 and 15) and *Colorado Revised Statutes* (CRS) (CRS 37-87-102 through 115), and develop alternatives, as necessary and appropriate, to correct the identified problem.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  — The Surface Water IMP Working Group determines the frequency and type of monitoring specified as appropriate to identify any structural problems in a timely manner consistent with standard industry practices and applicable regulations.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  — Does not apply.

Monitoring Requirements:

Monitoring requirements determined to safely operate the dams are presented in Table 2-1.

Table 2-1
Monitoring Requirements (Number of Samples/Analyses) for Safe Operation of Dams

Data Types Monitored	POND											
	A1	A2	A3	A4	B1	B2	B3	B4	B5	C1	C2	Landfill
Inflow rate (telemetry measurement)	—	—	9/day [SW093]	9/day [GS12]	—	—	—	—	9/day [GS09]	—	9/day [SW027]	—
Inflow rate (field measurement)	1/week	1/week	1/day	1/day	1/week	1/week	—	—	1/day	—	1/day	—
Discharge rate (telemetry measurement)	—	—	9/day [GS12]	9/day [GS11]	—	—	—	—	9/day [GS08]	—	9/day [GS31]	—
Discharge rate (field measurement during discharge)	4/day	4/day	4/day	4/day	4/day	4/day	—	—	4/day	—	4/day	4/day
Pond elevation (telemetry measurement)	—	—	9/day	9/day	—	—	—	—	9/day	—	9/day	—
Pond elevation (field measurement)	1/week	1/week	3/week	3/week	1/week	1/week	—	—	3/week	—	3/week	1/week
Piezometers (telemetry measurement)	—	—	3/day	3/day	—	—	—	—	3/day	—	3/day	—
Piezometers (field measurement)	—	—	1/week	1/week	1/week	—	1/week	—	1/week	—	1/week	1/week
Routine dam inspection	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week
Biannual detailed dam inspection	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year
Annual FERC and DOE dam inspection	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year
Inclinometer (field measurement)	—	—	—	4/year	—	—	—	—	4/year	—	4/year	—
Crest monument movement (field measurement)	—	—	—	4/year	—	—	—	—	4/year	—	4/year	—
Use of computer expert system to predict pond filling and/or discharge events (using data from telemetry and field measurement)	1/week	1/week	1/week	1/ week	1/week	1/week	—	—	1/ week	—	1/ week	1/week

Notes:

Where nine measurements per day are indicated, this is the estimated average of critical measurements that are actually targeted. This varies from daily to hourly, and the hourly capability is required for 50-100 days per year. Instantaneous measurement capability is also desired for telemetry data.

— = Not applicable
DOE = Department of Energy
FERC = Federal Energy Regulatory Commission
Specific automated gauging station locations shown as: [GS12] for example

46

2.2.2 Source Location Monitoring

As used in this section a "source" is a contaminant source. The term "new source" as used in this section means any source that has not yet been located, halted, mitigated, quantified, or corrected. The parties intend that this decision rule will initiate appropriate action, even though a source may exist prior to the implementation of this IMP.[5]

Problem Statement:

When new contaminant sources are detected by surface-water monitoring within the Industrial Area, at NSD locations, at POEs, at POCs, or in the downstream reservoirs, additional monitoring may be required to identify[6] the source and evaluate for mitigating action pursuant to the RFCA ALF. The Source Location Monitoring objective is used to locate the source of contamination when a new source of contamination is detected[7].

Information Types and Frequency:

Analyte suites under this decision rule are determined based on the contaminant of current concern that has caused the exceedance, or related indicators. The information types are entirely dependent on the results of other monitoring objectives under which the source was detected. The analyte suites are limited to parameters which will aid in the identification and evaluation of a contaminant source.

Boundaries:

Spatial: Source location monitoring may be implemented anywhere within the Site surface-water drainage area (especially within the Industrial Area) where a new contaminant source or exceedance is detected. The distribution of monitoring points is determined by the details of the specific source evaluation to determine source location and to efficiently utilize resources. For example, if monitoring (just outside the Industrial Area) for NSD suggests a new source within the Industrial Area, then portable monitoring equipment may be installed within the Industrial Area to locate the source. And, if monitoring for compliance in Segment 4 suggests a new source, then monitoring to identify the source may begin in Segment 5.

Temporal: Source location monitoring should begin as soon as practical after source detection and continue until the source is identified and evaluated or is no longer detected. The number of samples will be based on the status of the source evaluation, taking into account, but not limited to, weather conditions, water availability, and process knowledge.

[5] A decision rule under the DQO process links Site environmental data with operational and regulatory decisions.

[6] Note that the term "identify" is used here to mean "locate." Characterization is also implied.

[7] The various monitoring objectives might "detect" a new source through an increase over baseline or exceedance of an action level, standard, permit limitation, etc., depending on the monitoring objective under which the potential new source was detected.

97

Decision Statement:

IF A new contaminant source is identified by any monitoring objective—

THEN The Site will take appropriate and immediate action to halt or mitigate, locate and quantify the source, and implement mitigating action pursuant to the RFCA.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - — This decision rule is only invoked when new sources are detected under other monitoring objectives. Comprehensive monitoring for *detection* of new sources is an issue for other monitoring objectives. Comprehensiveness and representativeness may be developed for specific instances of source location actions.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - — A generally applicable statistical sampling design has not been used.

Monitoring Requirements:

The need for source location monitoring stations is dependent on the results of monitoring under other objectives. Therefore, it is impossible to estimate the exact monitoring targets under the Source Location Monitoring objective for each year. In FY97, Pu water-quality exceedances were detected at GS03, GS10, and SW093. As part of the source evaluation, eight source location monitoring stations were operated beginning in FY98. For planning purposes, Table 2-2 contains estimated analyses supporting these source evaluations, that would be performed at multiple source location stations, to locate and characterize the sources contributing to any of the exceedances.

2.2.3 *Ad Hoc* Monitoring

The Site often monitors surface waters on an *ad hoc* basis for a variety of reasons. This monitoring may or may not be used in decision making processes, but it has been frequently requested by DOE, RFFO, cities, agencies, building managers, and the WWTP in the past. The Surface Water IMP Team anticipates that the DOE, RFFO will continue to request such *ad hoc* monitoring in the future, regardless of whether funding is allocated for that purpose.

Table 2-2 Estimated FY99/00 Annual Number of Samples and Parameter Collection Frequency for Source Location Monitoring

Gauging Station : Location Description	Pu, Am	TSS	Total Samples/Year
GS33: No Name Gulch at confluence with Walnut Creek	12	12	12
GS34: Walnut Creek above confluence with McKay Ditch	12	12	12
GS35: McKay Ditch at confluence with Walnut Creek	12	12	12
GS38: Central Ave. Ditch NW of Building 889	12	12	12
GS39: Ditch N of 904 Pad; also supports 903 Pad remediation	12	12	12
GS40: Drainage Outfall E of Tenth St. S of Building 997; also supports 700 Area D&D activities	12	12	12
SW118: N. Walnut Creek west of Portal 3	12	12	12
SW120: To be installed Drainage Ditch N of Solar Ponds inside PA along perimeter road; also supports B771/774 D&D	12	12	12

This monitoring will not always require sample analyses. In some cases only flow alarms will be needed. Some examples that may warrant *ad hoc* monitoring include:

- Major precipitation events that disrupt routine pond predischarge monitoring and discharge schedules;
- Community assurance monitoring at the request of downstream cities and the DOE, RFFO;
- Unanticipated changes in regulatory permits, agreements, or funding;
- Anticipated but unfunded changes in permits or agreements;

- Construction projects;
- Spill events; or
- Operational monitoring (i.e. footing drains, septic lift stations).

The monitoring estimates for FY99 and FY00 in Table 2-3 are based on fiscal year 1997 (FY97) actual monitoring. Analytes listed are typical of current and past monitoring, but actual monitoring for future periods will certainly differ from this estimate.

50

Table 2-3 Example of Estimated Annual Ad Hoc Monitoring Requirements (Number of Samples/Analyses)

Analyses	995 Sand Filter Effluent	995 Influent	Pond A-3	Pond A-4	Pond B-5	Pond C-1	Pond C-2	Walnut Creek at Indiana	Woman Creek at Indiana	Total
Acute toxicity	—	—	2	—	—	—	—	—	—	2
Am-241	—	—	—	8	8	52	5	16	5	94
CBOD5	—	104	—	—	—	—	—	—	—	104
Fecal coliform	10	—	—	—	—	—	—	—	—	10
Gross alpha/beta	—	—	—	60	56	52	35	80	35	318
HSL metals	—	—	—	4	4	—	2	4	2	16
AA-Ag, As, Cd, Hg, Pb	—	—	—	4	4	—	2	4	2	16
NVSS	—	—	—	2	—	—	—	—	—	2
Pu-238	—	—	—	—	—	52	—	8	—	60
Pu-239/240	—	—	—	8	8	52	5	16	5	94
Tritium (H-3)	—	—	—	56	56	52	35	56	35	290
TSS	—	108	—	56	56	—	35	56	35	346
U-isotopic	—	—	—	8	8	52	5	16	5	94
Total samples for FY97	10	212	2	206	200	312	124	256	124	1446

Notes:

AA	=	Atomic absorption
Ag	=	Silver
Am	=	Americium
As	=	Arsenic
CBOD5	=	5-day carbonaceous biological oxygen demand
Cd	=	Cadmium
FY	=	Fiscal year
Hg	=	Mercury
HSL	=	Hazardous Substances List
NVSS	=	Nonvolatile suspended solids
Pb	=	Lead
Pu	=	Plutonium
TSS	=	Total suspended solids
U	=	Uranium

51

2.2.4 Monitoring for Correlation of Plutonium with TSS[8]

The Site intends to move toward controlled detention operation of the ponds at some time in the future. The initial controlled detention design basis indicator for Pu will be total suspended solids (TSS), which historical stormwater data have shown to be correlated with Pu activity (Gilbert, 1987) at several locations. This correlation was a primary assumption in the design basis for the controlled detention *Pond Operations Plan*[9] (Kaiser-Hill et al., 1996). To test these hypotheses, it is desired that samples be analyzed for Pu and TSS at selected monitoring locations planned for use during future controlled detention discharge from the ponds. This analysis may quantify the correlation between Pu and TSS.

Problem Statement:

This monitoring objective is intended to establish the relationship of Pu concentrations with several indicator parameters, such as TSS, turbidity, or flow rate. The determination of relationships between Pu and indicator parameters will support future pond operations, investigations into actinide transport, and management decision making.

The design basis for controlled detention is that Pu can be estimated as a function of TSS. Under controlled detention, the operational indicator might be turbidity, flow, or other indicators that can be monitored in real-time. This section also addresses the correlation of Pu with other parameters that can be monitored in real-time for operational decision making. TSS requires time for a laboratory analysis, so although it may provide a satisfactory design basis, it cannot be used as an operational indicator.

This section specifies data needed to develop deterministic regression models for estimating Pu concentrations in Segment 4 (below the terminal ponds) on the basis of TSS or turbidity data from Segment 5 (above the terminal ponds) and from within the Industrial Area. This section will also provide data for models that could estimate the magnitude of Pu contaminant sources within the Industrial Area on the basis of data from Segments 4 and 5. With respect to surface water, research indicates a relationship may exist between the amount of Pu activity and the amount of TSS in the water. Radionuclides, including Pu, tend to associate with particulate materials. When particles are transported in surface water runoff, radionuclides attached to the particles are transported as well. Therefore, measuring the amount of TSS in runoff from a specific drainage area can provide a characteristic ratio of Pu to TSS for that basin and insight into the amount of Pu activity being transported in the water.

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[8] Note: This section on the relationship of Pu with suspended particulates is *not complete*. The material in this section has been retained for future use, but several fundamental issues must be resolved, and a major rewrite will almost certainly be required before indicator monitoring should begin. Consensus on this section may be difficult to achieve due to the concerns surrounding controlled detention operation of Site ponds. However, all members of the Surface Water IMP Team have agreed that decisions regarding controlled detention should be well-informed decisions based on monitoring data such as is identified in this section.

[9] Pu is transported primarily on particulates in stormwater.

52

If an initial correlation between Pu activity and TSS is determined for a drainage basin, it would prove useful for monitoring future cleanup and containment of Pu within that area. For example, removing a source of Pu-contaminated sediments from a watershed would result in less transport of Pu from the basin, and, barring the creation of new sources of contaminated suspended sediments, the Pu activity associated with a given TSS concentration would also have been lowered. Therefore, a decrease in the ratio of Pu activity to TSS would be indicative of the effectiveness of the source removal. In contrast, an increased ratio might indicate a new source of Pu.

Data from this monitoring would also support evaluations of the impact of D&D and watershed improvement activities.

Information Types and Frequency:

To evaluate the correlation between TSS, turbidity, and flow with Pu, monitoring at any three stations would suffice, but *six stations* should be monitored in case some do not correlate well. Since Pu is already monitored at terminal pond outfalls (POCs) and at the Industrial Area boundary (POE and NSD locations), flow, TSS, and turbidity (turbidity monitored real-time) will also be monitored at these eight stations.

To evaluate the predictive capability of the real-time flow and turbidity parameters, the Site must monitor these parameters at locations most likely to be predictive and far enough upstream to provide at least 2 hours of warning before an exceedance could occur in Segment 4 (at a POC). These stations include POEs GS10, SW093, and SW027 and NSDs SW022 and SW091. Each of these stations will be equipped with real-time, water-quality probes to continuously monitor turbidity.

Ideally, TSS would be analyzed for all samples collected at the above locations. However, sampling protocols for these stations (detailed in Sections 2.4.1, 2.4.2, and 2.5.2) often result in composite samples that are collected over periods exceeding the 7-day hold time for TSS analyses. Therefore, TSS cannot be analyzed for all composite samples but will be analyzed when possible. For reference, NSD locations collect composite samples during singular runoff events, while POCs and POEs collect composite samples continuously during all flows.

Boundaries:

Spatial: Data may be acquired as far upstream as Segment 5 or even within the Industrial Area to predict Pu as far downstream as the reservoirs.

Temporal: No known constraints.

53

Decision Statement:

IF — The correlation between total Pu activity and TSS exceeds 0.80 at three or more monitoring location pairs[10] for a period of six months or more, including peak spring runoff events and base flow, (Gilbert, 1987) (see reference)—

THEN — Knowledge of this correlation is shared with the Actinide Migration Evaluation Team for further investigation. The Actinide Migration Evaluation Team will work with the RFCA monitoring team to determine whether the relationship between Pu and TSS is significant enough to be used as a design basis for operation of the ponds, and the Site may then attempt to establish the specific numerical values needed to design protective pond operations and structures. Results of these studies will be presented to stakeholders for consideration as a basis for operations.

An identical decision may be made for a relationship between Pu activity and turbidity, or a combination of TSS and turbidity, or other indicators. Note that use of the relationship between Pu and suspended particulates as a design basis for pond operations would not necessarily preclude real-time monitoring, short-term storage and screening, alternative routing of pond water, or other protective engineering features.

IF — The Site can demonstrate mathematically that a regression model of discharged Pu as a function of turbidity and/or flow and/or another real-time parameter[11] would provide at least 4 hours of warning before discharged Pu would exceed the applicable RFCA standard so that outlet works could be closed or so that the effluent could be redirected,

AND IF — A controlled detention terminal pond can be isolated from the WWTP and ITS—

THEN — The parties to this document will actively support a full one-year trial of controlled detention for that terminal pond, subject to approval of the operational plan.

[10] Monitoring location pairs: Theoretically, monitoring for TSS at GS10 (east edge of Industrial Area) may predict Pu activity monitored at GS08 (below Pond B-5). In this case, GS10 and GS08 would be a monitoring location pair.

[11] Precipitation and snow melting conditions may also provide an acceptable model.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - In order to provide a representative estimate of variability during FY99/FY00, it will be sufficient to monitor approximately one event per month at event monitoring stations (NSDs) and monitor a target of 20 samples taken over the full range of flow conditions, for each of the flow-paced stations (POEs and POCs). Monitoring at the POE and the NSD stations would represent the main drainage basins for which correlations are needed.
  - Each of the stations must continuously monitor for turbidity due to the method (continuous probe). Monitoring for Pu and TSS at each of the event monitoring stations (SW022 and SW091) during every sampled event would provide adequate confidence that significant events are sampled and representative at those locations. Monitoring for TSS at the flow-paced stations (GS10, SW093, SW027) should be performed only when Pu monitoring is performed and should provide at least 20 data pairs for FY99/FY00. The data set should include samples taken over the full range of flow conditions.
- *Acceptable Decision Error Rates for Statistical Sampling Design:*
  - Design of a sampling plan would require some knowledge of the variability, which is not yet available. Samples taken during FY99/FY00 will provide more of this variability information so that a statistical sampling design may be implemented when possible.
  - Acceptable decision error rate for the decision to accept the correlation between TSS and Pu as a design basis: $r^2 \geq 0.8$ for three or more locations.

Monitoring Requirements:

The requirements shown in Table 2-4 are partially redundant with other decision rule monitoring requirements, but are specified here to retain the independence and separability of the monitoring requirements for each decision rule.

Precipitation is currently measured in 5- and/or 15- minute intervals at nine locations around the Site. The effective precipitation for any monitoring location drainage basin can be calculated from these data.

Table 2-4 Annual Monitoring Targets (Number of Samples/Analyses) to Evaluate the Relationship of Plutonium with Indicator Parameters

Monitoring Location	Pu Analyses	TSS Analyses	Turbidity Measurement Frequency	Flow Measurement Frequency
Into the Ponds - Monitoring Indicators in Segment 5 for Pu in Segment 4				
SW093	10	10	15 min	15 min
SW027	10	10	15 min	15 min
GS10	10	10	15 min	15 min
SW022	12	12	15 min	15 min
SW091	12	12	15 min	15 min
Leaving the Ponds - Monitoring Pu in Segment 4, and correlation with Indicators				
GS11	10	10	15 min	15 min
GS08	10	10	15 min	15 min
GS31	3	3	15 min	15 min

Notes:

min = Minute
Pu = Plutonium
TSS = Total suspended solids

2.3 Industrial Area Monitoring Objectives

This section includes the monitoring objectives for decisions regarding the Industrial Area.[12] Some of the monitoring performed to make these decisions is actually performed outside the Industrial Area. For example, to detect a new source of contamination within the Industrial Area, the Site actually monitors surface water just after it flows out of the Industrial Area.

This Industrial Area Monitoring section also addresses monitoring of incidental waters, the sanitary sewer system, and performance monitoring. Immediately outside the buildings of the Industrial Area, the Site must often decide whether incidental waters (see Section 2.3.1) that accumulate in berms, utility pits, etc, can be discharged directly to the environment, or whether they must be treated. Discharges to the sanitary sewer system are monitored as discussed in Section 2.3.2. Internal waste streams are discussed in Section 2.3.2.1. To maintain current information in the NPDES permit application, the Site must characterize all routine internal waste streams to establish what else might reasonably occur in discharges from these processes.

[12] In the surface water monitoring objectives, the term "Industrial Area" is intended to include the 903 Pad. Runoff from the 903 Pad flows through monitoring stations SW022 and SW027.

56

Additionally, the Site routinely determines whether non-routine internal waste streams (Section 2.3.2.2) may be discharged from the Industrial Area to the WWTP. In addition, NPDES monitoring must be performed on the WWTP discharge to the ponds.

2.3.1 Incidental Waters Monitoring

Problem Statement:

Incidental water is precipitation, surface water, groundwater, utility water, process water, or wastewater collected in one or more of the following areas:

- Excavation sites, pits, or trenches;
- Secondary containments or berms;
- Valve vaults;
- Electrical vaults;
- Steam pits and other utility pits;
- Utility manholes;
- Other natural or manmade depressions that must be dewatered; or
- Discharges from a fire suppression system that has been breached within a radiological buffer area or a contamination area.

For example, many precipitation events leave rainwater in some utility pits and secondary containments. Disposition of such waters depends on the contaminants present, if any, that may have been picked up from the surroundings or containment structures. Waters containing oil, radioactive constituents, and hazardous substances may require management (e.g., treatment, storage, or disposal) under appropriate regulations, rather than by direct discharge. This Incidental Waters Monitoring objective provides for the routine data-driven decisions on whether to allow discharge of these incidental waters into the environment. The Site must determine how to manage incidental waters (i.e., whether or not to discharge to the environment[13]).

This decision includes only incidental (not routine) accumulations of water (not waste). Discharges of water containing oil, radioactive constituents, and hazardous substances above the established control limits are prohibited. This monitoring objective does not include decisions regarding appropriate treatment of contaminated waters for which authorization to discharge to the environment is denied. This monitoring objective does not require laboratory analyses of snow melt, rain water, groundwater, or potable water, unless there is reasonable cause to suspect contamination.

[13] The environment, in these cases, includes storm drainages, surface waters, and the surface of the ground.

57

Waters that are denied discharge authorization under this decision rule may be considered for discharge to the WWTP under the internal waste stream decision rule elsewhere in this plan, or they may be managed using other treatment, storage, or disposal options.

Data Types and Frequency:

The Site incidental waters program uses field screening observations and measurements, and chemical analyses for known or suspected constituents in order to determine the appropriateness of discharge to the environment. The field screening initial assessment is made on the basis of the screening criteria in Table 2-5.

Table 2-5 Incidental Waters Screening Criteria

Observation Parameter	Criterion
Process knowledge of the immediate vicinity	Professional judgement
Field pH using pH paper or similar indicator	pH 6 to 9
Appearance	Visible sheen or color
Field nitrate using probe, colorimetry, or similar indicator	10 mg/L
Field conductivity probe	700 μmho/cm^2

Notes:

μmho	=	Micromhos	L	=	Liter
cm^2	=	Square centimeter	mg	=	Milligram

Additional testing is performed when known or suspected contaminants exist, including tests for gross alpha/beta, volatile organic compounds, and metals.

Boundaries:

Spatial: This decision is restricted to accumulations of water within the Industrial Area, where such waters may accumulate in containment structures and be contaminated to levels unacceptable for discharge.

Temporal: Incidental waters are more common in rainy seasons, but may occur during any part of the year. Although the frequency of occurrence varies seasonally, there are no formal monitoring frequencies for the decision.

Decision Statement:

IF Incidental waters appear to be potable water or rain water accumulations that are collected in areas that have no potential for contamination (i.e., not individual hazardous substance sites, material storage or handling areas,

58

and high traffic areas) and initial screening tests or chemical analyses are negative—

THEN Incidental waters may be discharged to the environment at the discretion of the Surface Water Program manager. [14]

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - — The Incidental Waters Program is well established, and there is low probability that accumulations of incidental waters would go unreported and unevaluated before being pumped and discharged to the environment.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - — Recall that these accumulations of water in berms and utility pits are nearly always from rain, snow melt, groundwater, or potable water. If process knowledge, screening, and chemical analyses fail to indicate the presence of oil, or hazardous or radioactive substances, then the discharge is authorized. A single measurement or observation will be adequate, if performed at all. Therefore, a statistical sampling design is not applicable to this decision rule.

Monitoring Requirements:

Monitoring of incidental waters will require field observation and screening, and additional chemical analyses of an estimated 10 incidental water accumulations per month during FY99/FY00. For each instance, screening is required, with additional chemical analyses necessary when known or suspected contaminants exist. For planning purposes, estimated monitoring targets for this monitoring objective are presented in Table 2-6.

[14] Incidental waters may also be discharged to the WWTP, with approval of the WWTP manager. However, the decision logic for these DQOs is that incidental waters become internal waste streams if they fail to qualify for discharge to the environment. Logically, there are three possible outcomes for the incidental water: the water may be discharged to the environment, subjected to the internal waste stream decision, or the responsible organization may elect to employ other treatment, storage, or disposal options. Therefore, the formal decision for incidental waters addresses only the discharge to the environment. The decision to discharge to the WWTP is handled as the internal waste stream decision elsewhere in this document; and the decision to manage under other regulations is out of scope for this document.

Table 2-6 Estimated Field Test Monitoring Targets (Number of Samples/Analyses) for Incidental Waters)

Parameter	Justification	Measurements per Year FY99/FY00
pH	NPDES permit and stream standards restrict pH of plant discharges.	120
Nitrate as N	NPDES permit and stream standards have restrictive nitrate limitations.	120
Conductivity	Indicator parameter for metals. NPDES permit and stream standards restrict metals.	120
Gross alpha/beta	BMP to restrict radionuclides in SW discharges.	100
VOCs	NPDES permit and stream standards restrict VOCs in SW discharges.	40
Inorganic metals	NPDES permit and stream standards restrict metals in SW discharges.	10

Notes:

BMP = Best Management Practice
FY99/FY00 = Fiscal years 1999 and 2000
N = Nitrogen
NPDES = National Pollutant Discharge Elimination System
VOCs = Volatile organic compounds
SW = Surface water

2.3.2 Sanitary System Monitoring

Sanitary collection system monitoring may provide the Site D&D project managers and WWTP operators information about collection system condition within the Industrial Area as specific areas contributing to the WWTP flow. Current and prospective monitoring systems provide information about the relative contribution of the two main branches of the sanitary collection system and qualitative information about the content of flows through the headworks of the WWTP. Sanitary system monitoring is conducted to:

- Determine percent removals across the treatment plant and therefore be able to predict compliance or noncompliance with NPDES permit effluent limitations;
- Monitor explosive levels at the headworks for worker safety;
- Monitor for corrosive substances that may impact the treatment units;

UV

- Determine if influent concentrations and loads are trending up or down; and
- Monitor within the collection system to establish pollutant loads attributable to specific industrial internal waste streams (e.g., laundry water at the Site).

Five distinct monitoring requirements have been identified for sanitary system monitoring. Separate decision rules have been developed for each of these requirements. The first monitoring requirement is to characterize routine internal waste streams to meet NPDES permit requirements. This requirement is distinct from the second monitoring requirement which is for non-routine internal waste streams, for which separate decision rules have been developed. The final three requirements were identified for monitoring of the WWTP influent flows. These include collection system flow monitoring, WWTP protective monitoring, and WWTP radiological influent monitoring. The requirements and unique decision rules are described in the following subsections.

2.3.2.1 Internal Waste Stream Characterization to Meet Permit Requirements

Both of the next two sections deal with internal waste streams (IWS) but have very different decision rules and monitoring requirements. These IWS Monitoring objectives address two of the most conceptually complex surface water decisions to be made. These are decisions regarding disposition of contaminated waste streams produced on Site. Some can be discharged to the sanitary system, some must be treated under the Resource Conservation and Recovery Act (RCRA), some require treatment for radionuclides under DOE Orders, and some require management by still other regulations. These related issues, neither of which is monitoring required by the RFCA, are introduced below:

- The first main NPDES issue is that the Site must maintain strict compliance with NPDES permit conditions. This compliance requirement drives two distinct monitoring activities:
  - The Site must monitor permitted discharges as specified in the permit and report as specified in the permit. This issue of NPDES compliance monitoring is covered below.
  - The Site must manage discharges to the WWTP for two reasons that are combined operationally under the “authorization to discharge” process:
    1. The Site must ensure that the operational capabilities of the WWTP are not exceeded, resulting in a permit violation for the WWTP effluent. This activity is covered in Section 2.3.2.2.
    2. The Site must ensure that waste streams discharged to the WWTP are compliant with the NPDES permit, DOE Orders, and other regulations. This activity is also covered in Section 2.3.2.2.
- The second main NPDES issue is that of working with regulators toward well-informed decisions regarding permit conditions for the next NPDES permit or permit modification. (This is an ongoing process, so there is always a “next”

61

permit or permit modification.) The Site provides input to the decision process through preparation and maintenance of the NPDES permit application. This second monitoring issue is covered in this section.

The quantity and complexity of this activity will increase during D&D and implementation of the Rocky Flats Closure Project Management Plan. As the Site population decreases, the quantity of aqueous waste streams may decrease. But as the mission changes, waste streams will undergo significant changes that must be reflected in the permit application. New challenging waste streams will arise more frequently as buildings are deactivated and drained of their fluid contents and as other facilities modify their operations accordingly.

Problem Statement:

Determining appropriate permit conditions is, in part, a data-driven process. The Site provides the data, and the regulators make the decisions. Data for these decisions are provided in the NPDES permit application. Data used in the permit application include detailed information about waste streams emanating from buildings in the Industrial Area and discharged to the collection system. The nature of all Site waste streams and a detailed characterization of certain[15] discharges must be included in the permit application. These characterizations must include flow rates, constituents, and concentrations. Routine discharges are most likely to be monitored and may be incorporated in the NPDES permit.

Problem Scope:

The permit application has been supplemented with information about most internal waste streams and incidental waters that discharge to surface water. Sanitary discharges and waste streams from all Site buildings, and discharges from Building 374, the WWTP, and the terminal ponds are potential monitoring targets included within the scope of this section.

The main objective covered in this section is that the Site must keep the permit application current. This will require that the Site characterize new routine waste streams for disclosure in the permit application. The following are excluded from the scope of this section:

- Sanitary discharges of any quantity (internal waste streams) are subject to evaluation under Section 2.3.2.2.
- Incidental waters (which do not contain oil, or hazardous or radioactive substances) are covered in Section 2.3.1 of this document. Stormwater runoff monitoring is excluded from this section.

[15] The Clean Water Act (CWA) regulations require specific information about waste streams that arise from categorical processes identified in 40 CFR 400-500.

Data Types and Frequency:

- The following items are included in the permit application, as needed:
  - — Complete NPDES application,
  - — Update notifications that have been presented to the permitting agency,
  - — Current drawings for each facility,
  - — Descriptions of discharges from the facility to waters of the United States, and
  - — Current available characterization for each discharge.

Boundaries:

Spatial: The data collected for this monitoring objective is limited to the Industrial Area. All facilities and all storm water drainages from the Industrial Area are included.

Temporal: This section has no temporal boundaries; it deals only with present and future discharges. The permit application requires resubmission every five years.

The actual data-driven decision is made by the regulator. That is the decision whether to establish a permit condition, limitation, or requirement in response to a specific contaminant concentration in a specific discharge stream described in the permit application.

Decision Statement:

IF Any facility on Site discharges wastes to surface water directly or indirectly through a treatment facility—

THEN The discharge must be characterized and must be reflected in the permit application.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - — Site processes for review, notification, and approval of facility modifications are not fully implemented in some cases. Often, facility inspections are needed to provide complete identification and full disclosure of discharges. A planned approach to thoroughly inspect

63

facilities and processes should be used to provide completeness for the permit application.

- Acceptable Decision Error Rates for Statistical Sampling Design:

  — Regulatory emphasis is on full disclosure rather than on accuracy. A rigorous statistical treatment is inappropriate for this decision because typically only one analysis will be performed. Therefore, sampling variability will not be evaluated and will not drive additional sampling to achieve some desired confidence level. Analytical results are required to be representative of typical conditions in discharged waste streams, but failure to report a discharge carries a greater risk than flawed characterization. Therefore, completeness is more important than the rigor of a statistically designed sampling protocol, except in those cases where the Site elects to negotiate a specific issue and requires project-specific monitoring data to negotiate that issue. Such monitoring is not addressed in this plan.

Monitoring Requirements:

For planning purposes, it is estimated that three (3) new routine waste streams will require characterization each year during FY99/FY00 in order to maintain the NPDES permit application.

2.3.2.2 Monitoring Discharges to the WWTP

This section addresses the monitoring for granting authorization to discharge a waste stream to the WWTP. The Site must make frequent decisions regarding disposition of waste streams. Non-routine discharges must be evaluated prior to discharge into the WWTP. NPDES, RCRA, and other regulations prohibit discharge of some hazardous, toxic, radioactive, and otherwise regulated materials to the WWTP.

This section covers non-routine sanitary discharges. Incidental waters (which do not contain oil, or hazardous or radioactive substances) are covered in Section 2.3.1 of this document. Stormwater runoff monitoring is excluded from this section.

If waste streams may not be discharged to the WWTP, then they may need to be evaluated for treatment, storage, or disposal under appropriate regulations such as RCRA, CERCLA, or DOE Orders prior to discharge. However, monitoring for treatment decisions is outside the scope of this environmental monitoring plan.

There are five sets of criteria against which monitoring may be required to verify compliance, depending on process knowledge.

- NPDES regulations prohibit certain hazardous substances from being discharged to surface water. Table A-24 (see Appendix A to this section) shows a list of NPDES hazardous substances that must be considered (but not necessarily

44

analyzed) during the characterization of each internal waste stream. Sampling required to characterize each discharge is subject to process knowledge available and is limited to those analytes reasonably expected to be present.

- WWTP operational capabilities limit the loading of many substances and the values of some physical parameters, such as pH, in the WWTP influent stream. Table A-25 (see Appendix A to this section) specifies these limitations.
- RCRA hazardous wastes are also prohibited from being discharged to surface waters, and discharge to the WWTP is regulated. RCRA regulations for listed, characteristic, and derived hazardous wastes are included in this document by reference only.
- Oil in WWTP influent streams is limited to 100 milligrams (mg)/L unless a greater loading is specifically authorized by the WWTP manager.
- Radionuclides discharged to the WWTP are limited to loadings that will not result in exceedance of Segment 4 stream standards under RFCA. As low as reasonably achievable (ALARA) also applies to discharges of radionuclides.

Data Types and Frequency:

Process knowledge is the most valuable indicator. Process knowledge might include the source of the waste stream, current location, and historic precedent. Screening inputs are shown in Table 2-7. Additional chemical analyses are performed when process knowledge and screening results are insufficient to adequately characterize a waste stream.

Table 2-7 Internal Waste Stream Screening Tests

- Process Knowledge
  - — Location
  - — Source
  - — History
- Visible Sheen
- Color
- Clarity
- Volume
- Field Conductivity
- pH

63

Table 2-8 Requests (Number of Samples/Analyses) for Authorization to Discharge

Requests	Total	Approved	Denied
Number of Requests for FY98	63	58	4
Number of Requests for FY99 (through April)	32	31	1

Notes:
FY = Fiscal year
Numbers shown are examples for planning purposes in future years

All facilities within the Industrial Area are included under this monitoring objective. This monitoring objective has no temporal boundaries, except that it deals only with present and future discharges. All liquids for which a facility requests authorization to discharge to the WWTP are included under this objective. Examples include chemical solutions, condensate, foundation drainage, and some incidental waters that are not acceptable for discharge to the environment.

Decision Statement:

The ideal decision rule is stated below.

IF A waste stream for which a facility has requested authorization to discharge to the WWTP fails to qualify under any applicable regulatory criterion—

THEN Do not authorize discharge to the WWTP.

This ideal rule requires the decision maker to be virtually omniscient. Some finite, practical, and protective monitoring must be implemented to approach the ideal. The practical decision rules used to implement this monitoring objective are presented below.

IF Process knowledge and the standard screening protocol shown in Table 2-7 offer no reasonable cause to suspect prohibited contaminants in a waste stream for which authorization to discharge has been requested—

THEN The Site will grant authorization to discharge to the WWTP, subject to approval of the WWTP manager.

IF Screening results[16] or process knowledge indicate that contaminants would prohibit the discharge under any applicable regulation—

THEN The Site will either:

[16] Screening results may be single values or averaged values at the discretion of the surface water manager or WWTP manager.

- Deny the request to discharge; or
- Perform more specific analyses and evaluate the estimated contaminant load to the WWTP and estimated contaminant concentrations discharged to the main stream channels of waters of the state after passing through the WWTP or ponds.

IF More specific or more sensitive analyses indicate that the waste stream would not cause a violation of applicable regulations—

THEN The Site will authorize discharge to the WWTP with the approval of the WWTP manager.

The responsible organization may elect to perform additional analyses at their expense to resolve concerns raised by process knowledge or screening tests.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative and Acceptable Decision Error Rates for Statistical Sampling Design:
  - A single sample will typically be appropriate, and a statistical sampling design will not be needed.

Monitoring Requirements:

The Surface Water IMP Working Group estimates that there will be approximately 40 requests each year for authorization to discharge during FY99/FY00. Each will be screened as specified in Table 2-7. Waste streams with similar characteristics (i.e., acids or bases) may be grouped into single requests for administrative efficiency.

2.3.2.3 WWTP Collection System Protective Monitoring

At this time, collection system protective monitoring is minimal and consists of real-time monitoring for pH, conductivity, and Lower Explosive Limit (LEL) at two locations, in the equalization basins and at the headworks to the plant. Some manual pH readings are also taken by plant personnel at the headworks. As D&D proceeds and buildings with drains to the WWTP are impacted, the need to expand the collection system monitoring will be evaluated.

The pH and conductivity monitoring are indicators for corrosivity and spills. LEL readings are for protecting worker safety and have a separate decision rule.

Data Types and Frequencies:

The following indicators should be considered: pH, conductivity, LEL, and monitoring for radionuclides.

67

Boundaries:

Spatial: All collection system lines influent to the WWTP up to but not including lines inside the buildings inside the Industrial Area.

Temporal: This is real-time operational monitoring.

Decision Statement:

Proposed decision rules to be developed for FY99/00 are presented below.

IF pH or conductivity monitoring shows uncharacteristic changes over past results—

THEN The chief operator will be notified and will determine whether the influent should be rerouted to the flow equalization basin not currently in use while the problem is investigated.

IF The LEL is exceeded (see Table A-25)—

THEN Emergency procedures will be activated.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - To be determined.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - To be determined.

Monitoring Requirements:

To be determined.

2.3.2.4 WWTP Collection System Flow Monitoring

Flow information for the Site's sanitary collection system is currently limited to influent records for the WWTP. The initial scope of collection system monitoring is intended to provide Site collection system flow information by installing continuous recording flow monitoring equipment at (Building 990) on the two main collection system lines. The flow record will be used to establish annual baseline conditions for the flows from the protected area (PA) and non-PA areas. Changes from the established baseline flow may be attributable to normal collection system conditions such as infiltration and inflow, or abnormal conditions, such as increased flows from areas undergoing D&D.

68

Problem Statement:

The sanitary collection system consists of two components, one serving the Protected Area and one serving all areas outside of the Protected Area (PA and non-PA, respectively). Flows from the two areas remain segregated until they enter the equalization basins located at B990. Influent to the WWTP (B995) is monitored for pH, conductivity, and LEL on a continuous basis. These parameters are also monitored at B990 on both the PA and non-PA systems. None of these locations has a continuously recording flow monitoring device.

Data Types and Frequencies:

Installation of the described equipment will facilitate the collection of flow rates on the PA and non-PA collection systems. These inputs can be combined with currently recorded pH, conductivity, LEL levels, and precipitation and other existing continuous monitoring programs.

Boundaries:

Spatial: The areas described in the problem statement and scope are all areas at RFETS served by the existing sanitary collection system.

Decision Statement:

IF A baseline for flow does not exist—

THEN Develop a baseline and correlate its relationship with ground water levels and precipitation.

After developing a collection system flow baseline:

IF Flow in the PA or non-PA collection lines deviate from the baseline influent flows—

THEN Identify the source of abnormal flows and evaluate the impact on the sanitary collection system.

Monitoring Requirements:

Continuous flow monitoring of the sanitary collection system in the main transmission lines from the PA and non-PA areas into B990.

2.3.2.5 WWTP Radiological Monitoring

This section also includes the monitoring of radiological parameters at the influent to the WWTP for the purpose of tracking pollutant loads coming through the WWTP collection system. The assumption is that these radiologic loads to the WWTP should be decreasing, since the Site has systematically tried to eliminate any possible connections between wastestreams containing radionuclides and the collection system.

Problem Statement:

With the onset of D&D activities and remedial actions, the possibility of introducing contamination into the WWTP exists. Monitoring is one way to track whether there is an impact by an unknown source to the WWTP as a result of clean up activities.

Data Types and Frequencies:

Influent WWTP monitoring will include the suite of radiological parameters: isotopic Pu, Am, uranium (U), tritium, plus alpha and beta activity. Influent flow is also a required input in order to determine the loading into the treatment plant. Effluent WWTP monitoring includes the suite of radiological parameters: isotopic Pu, Am, U, tritium, plus alpha and beta activity.

Boundaries:

Spatial:	All collection system lines influent to the WWTP and WWTP effluent.
Temporal:	Present and future influent and effluent to the WWTP.

Decision Statement:

IF	A baseline for influent radiological levels does not exist—
THEN	Establish a baseline with initial loading data for WWTP radiological influent monitoring.

After developing a influent radiological baseline:

IF	Influent loading for any radiological constituents show a significant increase over the established baseline—
THEN	An evaluation will be conducted to determine potential cause.

The WWTP radiological effluent monitoring data will be compared with influent data to evaluate WWTP removal efficiency.

Monitoring Requirements:

For the 1999 IMP, the Site collected a 24-hour composite sample at the headworks to the WWTP, at a time representative of full operation of the complex (not on weekends). The volume of flow associated with the 24-hour composite needs to be provided by the Site and made available to CDPHE. CDPHE will pick up the composite sample from the Site and will perform the analyses and calculate the loadings. For 1999 CDPHE has projected to report on influent quality once per month. Additionally, for FY99 CDPHE also collected a quarterly sample from the effluent of the WWTP. This sample was

70

composited in the same manner as the sample from the headworks. CDPHE analyzes for several constituents including isotopic Pu and Am, total U and metals.

The Site collects an 8-hour composite sample of WWTP effluent once a month. The sample is analyzed for isotopic Pu, Am, U, and tritium. Alpha and beta screens are performed twice monthly.

Sampling protocol and data quality objectives for WWTP monitoring are specified in the related sampling and analysis plan.

2.3.3 Performance Monitoring

Problem Statement:

This section addresses monitoring the performance of specific actions[17] on-Site for the release of contaminants to the environment. Project-specific performance monitoring may be detailed in a project plan through the review and approval process when the project poses a concern for a specific contaminant release, especially for a contaminant that may not be adequately monitored by other monitoring objectives downstream. Each performance monitoring location will target the contaminants of greatest concern for the specific action being monitored. For example, performance monitoring for specific analytes may be needed for:

- D&D Actions: The review and approval process for a D&D action may identify the need for performance monitoring specific to that action.
- Remedial Actions: There are monitoring requirements associated with specific Operable Unit (OU) activities. For example, the existing consolidated treatment plant for OU1 and OU2 has a surface-water discharge. Performance monitoring specific to this discharge is specified in the work plans.
- Transition Actions: For example, DOE, RFFO has proposed changes in the operation of the ITS. Specific performance monitoring may be needed in light of this change if other monitoring in this IMP fails to provide adequate assurance of protecting the environment and public health.
- Best Management Practices (BMPs) for the Control of Plutonium Transport in Surface Water Runoff: For example, when a BMP (barrier, trap, filter, or other watershed improvement) is installed to control a potential source of Pu-contaminated runoff, the Site would like to determine the effectiveness of the BMP so that resources may be allocated where they are most effective.

Monitoring of activities within the Industrial Area is achieved, in general, through the NSD and POE monitoring (see Sections 2.4.1 and 2.4.2 for details).

[17] This is project specific versus the global monitoring (NSD and POE) of the Industrial Area discussed in Sections 2.4.1 and 2.4.2.

71

Project-specific performance monitoring stations must be portable to monitor specific high-risk Site activities, such as D&D activities for a particular building. These mobile, temporary stations will be placed upstream from the routine monitoring stations, closer to specific Site activities to monitor a sub-basin for releases of contaminants specific to the activity in the sub-basin.

Boundaries:

Spatial: Performance monitoring can occur anywhere within the Site surface-water drainage areas (especially within the Industrial Area), downstream from a BMP, remediation, or high-risk activity.

Temporal: Generally, monitoring is initiated with enough time prior to project activities such that 10 - 15 samples over varying flow rates can be collected (preferably 18 months prior to project initiation[18]). Results from these samples are used to establish a baseline for the sub-basin. Monitoring continues during the activity attempting to collect one sample per month. After project completion, monitoring continues long enough to determine any beneficial impacts to surface-water quality.

Data Types and Frequency:

The types of data to be collected must be specified in the project plan. Analyte suites are generally determined by the constituents of concern associated with a specific activity or location. Generally, automated samples are flow-paced composites of 15 grabs taken on the rising limb of a runoff event. However, protocols may be modified depending on the specific conditions for a monitoring location or drainage basin. For example, a location with substantial groundwater seepage or a periodic footing drain discharge may warrant monitoring of those flows. Regardless, the sampling protocols are designed to accurately characterize existing flows and confidently monitor for changes during the project activities.

With the administrative transfer of OU2 monitoring (see Table 2-9) to the IMP to facilitate closeout of OU2 IM/IRA activities, quarterly grab samples are collected and analyzed as specified in the OU2 closure document. Reporting for these locations will be included in the quarterly report and no longer be reported in the Consolidated Water Treatment Facility report.

[18] Due to the dynamic nature of Site Cleanup, initiation of performance monitoring 18 months prior to an activity is rarely achieved. However, additional samples are often collected at an increased rate to establish baseline prior to initiation of project activities.

12

Decision Statement:

Decision rules must be specified for individual projects. A project-specific indicator might be a single monitoring result, a 30-day average for a specific analyte, or an indicator for the analyte of concern. Example decision rules are shown below.

IF	The project-specific indicator is greater than the 95% upper tolerance level (UTL) of baseline—
THEN	The Site will evaluate the specific activity to improve performance.
IF	The project-specific indicator is less than the 95% lower tolerance level (LTL)—
THEN	The Site will conclude that the project has reduced environmental releases of the specific contaminant.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - The specific project plan must specify an adequate monitoring method.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - The specific project plan must specify the decision criteria. Examples are shown in the decision rule section, above.

Monitoring Requirements:

Monitoring details will be specific to the project. The projected performance monitoring to take place in FY99 is given in Table 2-9. Analyte suites and sample collection protocols are project-specific and are contained in the individual project plans for automated locations. This same information can be found in the Surface Water (SW) Monitoring Technical Design Document (RMRS, 1996) which can be obtained from RMRS Water Management and Treatment (WM&T) personnel. The performance monitoring for FY00 will depend on Site closure activities and schedules.

73

Table 2-9 Projected FY99/00 Performance Monitoring Locations

Location Code	Location Description	Project	Supporting Documentation
GS27	Small ditch NW of B884	D&D of B889; Watershed Improvements evaluation	SW Monitoring Technical Design Document
GS32	Corrugated metal pipe (1.5 ft) north of Solar Ponds in PA draining B779 area	D&D of B779	SW Monitoring Technical Design Document
GS39	Corrugated metal pipe (1.0 ft) north of 904 Pad draining 903/904 Pads and Contractor Yard areas	ER projects for 903 Pad; also serves as Source Location monitoring station for GS10 Source Evaluation	SW Monitoring Technical Design Document
GS43	Small ditch NE of B886	D&D of B886	
SW061[19]	S. Walnut Creek upstream of B995	OU2 Closure	Final Surface Water Interim Measures/Interim Remedial Action Plan/ Environmental Assessment and Decision Document, S. Walnut Creek Basin
SW120; To Be Installed	Drainage ditch N of Solar Ponds along PA perimeter road	D&D of B771/774	
SW132	S. Walnut Creek, outfall of culvert draining 700 and 900 Areas, south of B995	OU2 Closure	Final Surface Water Interim Measures/Interim Remedial Action Plan/ Environmental Assessment and Decision Document, S. Walnut Creek Basin

[19] The inclusion of SW061 and SW132 monitoring in the IMP completes the OU2 IM/IRA administrative transfer of former OU2 monitoring.

74

2.3.4 National Pollutant Discharge Elimination System Permit Monitoring

The NPDES permit program controls the release of pollutants into the waters of the United States and requires routine monitoring of point source discharges and reporting of results. The Site's first NPDES permit was issued by EPA in 1974. The current permit was reissued by EPA in 1984, expired in 1989, and has been administratively extended to date. A draft permit has completed the public comment process and is awaiting issuance by EPA. All monitoring for NPDES compliance is prescriptively required by EPA and is not covered by the IMP process or detailed in this document. Please refer to the current permit for specific monitoring requirements.

Current Permit:

The current permit for the Site identifies six monitoring points for control of discharges. These locations include the effluent of the WWTP, two interior ponds, and three terminal ponds capable of discharging water off Site. The NPDES permit terms were modified by the Federal Facility Compliance Agreement (FFCA) signed on March 25, 1991 (DOE, 1991). Modifications included the elimination of inactive discharge points and inclusion of new monitoring parameters at other discharge locations.

Draft Permit:

The draft permit for the Site is expected to address only two permitted discharge points, the WWTP effluent and Building 374 product water effluent. The other previously permitted discharge locations will be regulated under CERCLA via the RFCA. Additional expanded scope includes plans and procedures for operations of influent/effluent storage tanks, influent monitoring at WWTP, internal wastestream monitoring, stormwater monitoring, stormwater pollution prevention plan, and WWTP influent real-time radiological monitoring feasibility study.

2.4 Monitoring Objectives for Industrial Area Discharges To Ponds

This section addresses monitoring of surface water before it arrives in the terminal ponds (i.e., surface waters running off of the Industrial Area to Segment 5 waters upstream of the terminal ponds). These discharges are the major transport pathways available for contaminants leaving the Industrial Area. Ongoing activities and remediation tasks at the Site could create new contaminant source areas within and around the Industrial Area and could thus degrade downstream surface-water quality. For example, a D&D or remediation project could result in the release of contaminants to soils near the facility, which could be transported via runoff into Site drainages, and possibly off-Site.

The Site must monitor runoff to detect significant spills or leaks from ongoing activities such as remediation, D&D, construction, and continuing operations. Merely monitoring the terminal pond discharges is not adequate to protect water quality above the terminal ponds (in compliance with RFCA requirements), or to detect acute contaminant runoff from significant new sources within the Industrial Area.

75

2.4.1 New Source Detection Monitoring

The NSD Monitoring objective provides comprehensive coverage of the entire Industrial Area but is not specifically focused on individual actions within the Industrial Area. Performance monitoring of specific activities within the Industrial Area (or elsewhere) may be carried out under the Performance Monitoring objective. This NSD objective monitors the performance of all remedial activities within the Industrial Area with respect to their impact on surface waters. However, it does not necessarily identify and locate a specific source within the Industrial Area.[20] This monitoring objective provides for monitoring of all main drainages from the Industrial Area into the three main channels of Stream Segment 5.[21]

This NSD monitoring is one of many possible spill response actions, but spill response is not the primary focus of the NSD Monitoring objective. Sampling and analysis of spills is addressed in other Site planning documents, such as the *Spill Prevention, Control, and Countermeasures/Best Management Practice Plan* (SPCC/BMP) (EG&G, 1992a).

Data Types and Frequency:

This decision requires contaminant concentration data from surface-water samples taken at permanent monitoring locations located on the five main surface water pathways to the Site detention ponds. Analyses are performed for each of the contaminants and parameters listed below in order to establish a baseline. After a baseline has been established, evaluations will be performed as required by the decision rules. The basis for selecting these contaminants of concern and indicator parameters is described below.

- Isotopic Pu, U, and Am are primary contaminants of concern.
- Turbidity, pH, nitrate (NO_3), and conductivity are measurements performed continuously because they are inexpensive per measurement and can be used as real-time indicators to provide or negate reasonable cause to analyze for other specific contaminants.
- Turbidity may indicate increased contaminant loads in general and increased Pu specifically. (Pu in surface water is generally bound to particulates.)
- pH can be used to detect an acid or caustic spill.
- Nitrate may be useful in detection of chemical spills that include plutonium nitrate.

[20] Location of a specific source would be performed under the Source Location Monitoring objective in Section 2.2.2.

[21] The Site also desires early detection of smaller releases within the Industrial Area, by monitoring closer to the anticipated sources during D&D activities. This will be achieved through the Performance Monitoring objective (see Section 2.3.3).

76

- Conductivity can be used to corroborate a pH reading and to detect salt solution spills or metal spills such as chromium (Cr), beryllium (Be), silver (Ag), or cadmium (Cd).
- Precipitation can be used to determine whether a flow event is rain/snow runoff or a spill. Precipitation data is collected at nine locations across the Site. Effective precipitation for a given monitoring location drainage can be calculated.
- Water flow rate is needed to identify an event, trigger an automatic sampler, control the flow-paced sampling, and evaluate the magnitude of the spill or contaminant source (mass loading).
- Small changes to baseflow not attributable to rain or snowmelt or an unusual runoff hydrograph shape may indicate a spill.

This monitoring objective is limited to information collected at the Industrial Area boundary, as represented by surface-water monitoring stations SW022, SW091, SW093, SW027, and GS10[22] (see Figure 2-4). This monitoring focuses on runoff into the three main drainage areas leaving the Industrial Area: North Walnut Creek, South Walnut Creek, and the South Interceptor Ditch/Pond C-2 drainage (see Figure 2-3 and Figure 2-4). Normally, SW022 waters are subsequently monitored at GS10, so there is some redundancy in this set of monitoring stations. SW022 has been included at the request of the EPA to provide increased sensitivity for its drainage area. SW022 would also be used to determine the location of any new source detected at GS10.

For SW022 and SW091, sampling is event-specific, focused on the time period during which the first flush conditions prevail; specifically, the time period during the rising limb of a direct runoff hydrograph after any storm event. Automatic samplers are triggered when direct runoff is detected at the location [for example, >0.1 cubic feet per second (cfs); location specific].[23] The sample is analyzed when the runoff volume [for example, >25,000 gallons (gal)] is sufficient such that a flow-paced composite sample (in a 15-L container) can be collected that represents the first flush (presumed water-quality worst case). Seasonal adjustments are applied to define the conditions that represent first flush and direct runoff. Professional judgement will be used to select the most representative sample for each month from each station for analysis, when a sample is available for that month at that station. Samples are selected to provide analytical results for rising limbs with varying flow rates and runoff characteristics. This monitoring pushes the limits of the sampling equipment, and collection of one representative sample a month is an appropriate goal.

[22] Subdrainage monitoring stations within the Industrial Area are used for performance monitoring and source location but are excluded from the planned monitoring for this NSD decision rule.

[23] Note that specific boundary conditions are not procedural, legal, quality assurance (QA), or policy requirements. They serve only to clarify the objective so that a decision rule can be articulated. The flow rate and volume given in the text are only examples and may never actually be used in the field. These parameters vary greatly, depending on the season and the character of runoff events common during that season (e.g., snow melt or thunder shower). The parameters are selected such that representative samples can be collected on the rising limb for varying flow rates, runoff conditions, and seasons.

77

For SW093, GS10, and SW027, the information used in the NSD objective will be the same data as collected from the continuous flow-paced sampling used for monitoring Segment 5 action levels (see Section 2.4.2). These POE stations have baseflow, whereas the other two stations do not.

Only surface-water runoff from the Industrial Area is included, (i.e., baseflow, stormwater runoff flow, and spills to surface water). Spills are only included in this NSD monitoring as a secondary monitoring objective if an increase in flow rate is detected and cannot be attributed to precipitation, snow melt, or other previously monitored discharge. However, other management controls (e.g., SPCC/BMP) address monitoring of spills as a primary objective. These locations also provide confirmation that containment measures for spills or accidental discharges have been effective through monitoring of the real-time indicator parameters and subsequent analyses of collected samples.

Indicator monitoring will be performed for the parameters specified at the top of each column of Table 2-10. The first three columns are AoIs monitored directly through sample analytical measurements. Although these three columns and rows have a different relationship than the others, they have been included so that all monitored parameters are shown on the same table. The remaining columns are indicator parameters that are monitored with inexpensive real-time probes in lieu of analyzing for the AoIs identified at the left of each row. If a significant increase is detected in any one of these indicator parameters, then there is reasonable cause to suspect the presence of the AoI identified at the left end of the row in which an "X" appears. For example, if the nitrate probe detects a high nitrate concentration, then the Site would have reasonable cause to suspect the presence of plutonium nitrate, extreme pH, cadmium nitrate, and, of course, high nitrate, all of which are AoIs for Segment 5. If there were reasonable cause to suspect the presence of these AoIs, then the Site could perform additional analytical procedures specific for the AoI.

Decision Statement:

Screening for reasonable cause to suspect a new source:

IF	The mean concentration of any of the screening indicator variables in Table 2-10 exceeds the 95% UTL of baseline for that variable—
THEN	The Site will evaluate the need for further action under RFCA ALF, such as source evaluation and control. Evaluations will address persistence, trends, and risk of action level exceedances at POEs.

78

Table 2-10 Screening for New Source Detection AoIs vs. Indicator Parameters

	Routinely Monitored Parameters							
	Monitored AoIs			Indicator Parameters for AoIs				
AoIs	**Pu**	**U**	**Am**	**Turbidity**	**pH**	**Conductivity**	**NO_3**	**Flow Rate and Precipitation**
Plutonium	X			X			X	X
Uranium		X						X
Americium			X	X				X
Turbidity				X				X
pH					X		X	X
Conductivity						X		X
Nitrate						X	X	X
Chromium					X	X	X	X
Beryllium						X		X
Silver						X		X
Cadmium						X	X	X

Notes:

Am	=	Americium
AoIs	=	Analytes of interest
NO_3	=	Nitrate
Pu	=	Plutonium
U	=	Uranium

79

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - The Site desires detection through sampling of runoff events within a month of a significant new contaminant release.[24] This is achieved through sampling all major drainages from the Industrial Area during high flow and analyzing approximately one sample per station per month. The Site must monitor runoff events at four locations (SW093, SW091, GS10, and SW027) to provide an acceptable level of confidence that significant events will be observed. Monitoring at SW022 is not required for the desired confidence.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - Baseline is defined by an average value for the parameter of interest over all monitored precipitation events for a single baseline year, at the discretion of the DOE, RFFO. A single measured value is accepted as representing a contaminant of interest. If a single measured value exceeds the 95% UTL of baseline, that will provide adequate confidence of new source detection and invoke the action(s) specified by the decision rule.

Monitoring Requirements:

Table 2-11 presents detailed monitoring requirements for this decision rule. Analytical and real-time, water-quality probe indicator monitored parameters are in Table 2-10.

[24] Runoff events may be more than a month apart. The intent here is to detect a release to the environment from within the Industrial Area that is being flushed out of the Industrial Area by a runoff event within a few weeks.

90

Table 2-11 Monitoring Requirements (Number of Samples) for New Source Detection

Monitoring Station	SW093	SW091	GS10	SW027	SW022
Sample Analyses					
Total Pu-239/240	12/year[a]	12/year	12/year[a]	12/year[a]	12/year
Total Am-241	12/year[a]	12/year	12/year[a]	12/year[a]	12/year
Total U Isotopes	12/year[a]	12/year	12/year[a]	12/year[a]	12/year
Real-Time, Water-Quality Probe Indicator Parameters					
pH	15-min	15-min	15-min	15-min	15-min
Specific Conductivity	15-min	15-min	15-min	15-min	15-min
Turbidity	15-min	15-min	15-min	15-min	15-min
Nitrate	15-min	15-min	15-min	15-min	15-min
Flow	15-min	15-min	15-min	15-min	15-min
Precipitation	Site-wide locations				

Notes:

[a] Only SW091 and SW022 will be monitored for the rising limb of the hydrograph, as originally specified for this decision rule. Stations SW093, SW027, and GS10 are the Segment 5 action level (POE) monitoring stations. At these Segment 5 stations, NSD will be performed by statistically testing the flow-paced sample results. The same test criterion will be used, except that flow-paced samples will be tested against flow-paced variability. These locations will collect more than the target 12 samples for the NSD objective. All results collected at these locations under the POE objective will be used in the NSD objective.

Am	=	Americium	Pu	=	Plutonium
U	=	Uranium	min	=	minute

2.4.2 Stream Segment 5/Point of Evaluation Monitoring

This monitoring objective deals with POE monitoring of Segment 5 for adherence with RFCA action levels. RFCA provides specific criteria for virtually every possible contaminant for the main stream channels of Segment 5. In Table A-26 (presented at the end of this section in Appendix A), the DQO team identified a subset of those contaminants that are of sufficient interest to warrant monitoring. Figure 2-3 illustrates the stream segments, and Figure 2-4 shows the monitoring points used for various decisions.

81

Responses to exceedances at POEs are different than the responses associated with contaminated runoff before it reaches Segment 5 or after it enters Segment 4. Industrial Area monitoring upgradient of Segment 5 is designed to detect new contaminant sources within the Industrial Area. Downstream, Segment 4 is monitored at POCs to determine compliance with RFCA standards. This subsection of the document deals with POE monitoring of Segment 5 for compliance with RFCA action levels.

Historical data indicate that several regulated contaminants may exceed their RFCA action level criteria at the designated POEs. Such exceedances will require source evaluation and the development of a mitigation plan. The initial response to these exceedances might be to invoke the source location decision rule, perform special monitoring tailored to the specific source evaluation, and take action upstream of Segment 5 to protect Segment 5 from contaminant sources that caused such exceedances.

Data Types and Frequency:

The necessary decision inputs are those analytes specified as the Segment 5 AoIs per Table A-26 (see Appendix A to this section), as sampled at the POEs for Stream Segment 5. Segment 5 includes the terminal ponds (A-4 and B-5), and the main stream channels of North and South Walnut Creek, Pond C-2, and the SID. Monitoring will be performed for Stream Segment 5 only as represented by POEs SW093, GS10 and SW027 (see Figure 2-4).

Sampling for AoIs at POEs is performed by collecting continuous flow-paced composite samples. Indicator parameters are measured using real-time, water-quality probes. These AoIs and indicator parameters are evaluated using 30-day or 1-day moving averages, as specified in RFCA[25] and implemented by the ALF or DQO working groups involving consensus of all parties to RFCA. Pu, Am, U, Be, Cr, dissolved Ag, and dissolved Cd are evaluated using volume-weighted 30-day moving averages at these POEs.[26] Indicator parameters pH and nitrate are evaluated as one-day arithmetic averages (averaging of pH takes into consideration the logarithmic characteristics of pH measurement).

Moving averages are to be calculated for the preceding period, verified by additional analyses at the discretion of the monitoring organization, and formally reported to the DOE, RFFO within 30 days of gaining knowledge that an exceedance may have occurred (i.e., within 30 days of receiving a high analytical result). This 30-day period allows time for verification analyses after the monitoring organization gains knowledge that an

[25] Moving averages are to be calculated on whatever data are available, which may range from N=0 to more nearly ideal sample sizes computed on the basis of variability and confidence levels, unaffected by budgetary constraints. Where N=0, the average is not available. Where N=1, the average is the value for that single sample.

[26] The 30-day average for a particular day is calculated as a volume-weighted average of a "window" of time containing the previous 30-days which had flow. Each day has its own discharge volume (measured at the location with a flow meter) and activity (from the sample carboy in place at the end of that day). Therefore, there are 365 (366 in a leap year) 30-day moving averages for a location which flows all year. At locations that monitor pond discharges or have intermittent flows, 30-day averages are reported as averages of the previous 30 days of greater than zero flow. For days where no activity is available, either due to failed laboratory analysis or NSQ for analysis, no 30-day average is reported.

82

exceedance may have occurred before formal notification to DOE, RFFO of an actual exceedance is required. RFCA requires that DOE, RFFO inform regulators within 15 days of DOE, RFFO gaining knowledge (not just a suspicion) that an exceedance (verified) has (actually) occurred. During this 45-day period between first suspicion and formal notification to regulators, the DOE, RFFO may initiate discretionary mitigating action. The delay interval will prevent undue public alarm when the initial high result is not confirmed by subsequent monitoring. Informal communications between the parties are intended during the delay interval.

Decision Statement:

IF — The appropriate summary statistic[27] for any AoI[28] in the main stream channels of Stream Segment 5, as monitored at the designated POEs,[29] exceeds the appropriate RFCA action level—

THEN — The Site must notify EPA and CDPHE, evaluate for source location, and implement mitigating action[30] if appropriate.[31]

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - The flow-paced monitoring method ensures that significant events will be sampled. This method involves taking a fixed volume [e.g., 200 milliliters (ml) or 1 L] into the composite sample carboy (e.g., 15 - 22 L) as each Nth volume of flow [e.g., 500 L or 73,000 cubic feet(ft^3)] passes the monitoring point. Approximately 75 to 110 grab samples can be composited in the sample carboy with sufficient grab sample volume repeatability.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - Variability is not known for flow-paced monitoring. Therefore, decision error rates cannot be estimated. Sampling design was based, instead, on historical flow and professional judgement.

The decision error types and consequences for Segment 5 are presented in Table 2-12.

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[27] Appropriate action levels and standards for volume-weighted, 30-day moving averages or 1 calendar-day arithmetic averages, are specified for individual contaminants in RFCA.
[28] AoIs are specified in Table A-26 in Appendix A to this section.
[29] POE monitoring stations for Segment 5 are designated in Figure 2-4.
[30] Mitigating action may include, but not be limited to, the following examples: 1) immediate action to halt a discharge or contain a spill; or 2) use of the source location decision rule to seek out and mitigate upstream contaminant sources.
[31] RFCA may actually specify consequences for an exceedance of any action level (not just those for AoIs) at any location within the segment (not just at the consensus monitoring points). This decision rule presents the consensus decision rule that drives our monitoring activities. It is an implementation, rather than a reiteration, of RFCA.

83

Statisticians from the Pacific Northwest National Laboratory (PNNL) evaluated sampling protocol designs based on the decision error limitations shown in Table 2-12, but historical data were inadequate to determine the number of samples needed to meet these decision error limitations.[32] Therefore, the statistical design team recommended a pilot study or alternatively that the initial design be based on flow. This design should be reevaluated (vs. Table 2-12) after flow-paced data become available.

Table 2-12 Decision Error Types and Consequences in Segment 5

Error Type	Consequences
Failure to determine that an exceedance has occurred.	If the true average concentrations of AOIs are above RFCA action levels but data fail to detect this, the Site may not be compliant with RFCA.
Incorrect determination that an exceedance has occurred.	The Site would be required to provide notification, planning, a schedule, and response action that consumes limited resources when no exceedance had actually occurred, and the response would not be justifiable.

The decision error limitations shown in Table 2-13 were not used to design and specify the FY99/FY00 monitoring targets. They are retained here, however, for use in future sampling designs when variability becomes known for the flow-paced sampling method. Note that the decision error limitations shown in Table 2-13 are based on the assumption that failure to detect an exceedance is more important than falsely reporting an exceedance when no exceedance has occurred. The DQO team discussed this issue, but consensus was not achieved. When flow-paced data become available and the sampling design is reevaluated, this issue will be resolved.

[32] Actually, the statisticians were able to provide sample sizes based on historical data variability, but these sample sizes were impractically large due to the high variability in historical sampling methods (storm flow samples taken from the rising limb of the hydrograph). Because the FY98/FY99 monitoring at POEs will use, in part, the flow-paced method (with much lower variability expected) sample sizes based on historical variability would be inappropriate.

Table 2-13 Proposed Decision Error Limit Design Constraints for Segment 5 Monitoring

"Assumed-True" Parameter Value	Correct Decision	Acceptable Probability of Making an Incorrect Decision
0.1 x action level	Does not exceed action level	0.05
0.5 x action level	Does not exceed action level	0.10
0.5 to 1 x action level	Does not exceed action level	Gray region: No probability specified
2 x action level	Exceeds action level	0.05
4 x action level	Exceeds action level	0.01

Note: This table is retained for future use, but was not used for FY99/FY00 decision rules.

Monitoring Targets:

The recommended monitoring design for the Site is to take samples for FY99/FY00, as specified in Table 2-14, and analyze each sample for the Segment 5 AoIs specified in Table A-27, attempting to take no less than one sample per quarter and no more than four sequential carboy samples per month from each of the three monitoring points for each month. The ideal sampling rate is one 15-L sample carboy for each 500,000 gallons of stream flow, and each 15-L sample carboy should comprise approximately 50 flow-paced grab samples.

Table 2-14 presents the number of samples per month recommended by statisticians at PNNL. There are both practical and statistical advantages to this sample allocation design. Averaging a larger number of samples is more expensive, but it protects the Site from regulatory action in response to a spurious non-representative monitoring result.

There are secondary advantages to this monitoring plan. A larger number of samples allows for estimates of variability that can be used to refine the monitoring plan over time. The monitoring program specified here is a technically defensible approach that represents a compromise between a statistical design, a design based on professional judgement, and a design based on budgetary constraints. This design will generate data that are representative of actual contaminant levels and loads.

This design is consistent with the intent of the 30-day moving average specified in RFCA but allows some flexibility. Where there is no significant flow, there may be no samples completed within a 30-day period, and where the flows, loads, and variability are expected to be higher, sample numbers are also higher. Note that flow-paced monitoring will continue during dry periods, even though flows may be so low that it takes more than 30 days to fill the composite sample carboy.

Table 2-14 Monitoring Targets (Annual Number of Composite Samples) for Segment 5 POEs

	SW093	GS10	SW027
Month	**Number of Samples**		
October	**3**	3	0
November	4	3	0
December	2	1	1
January	2	1	0
February	2	2	0
March	4	4	1
April	4	4	4
May	4	4	4
June	4	4	4
July	2	3	0
August	2	2	1
September	3	3	1
Annual Total	36	34	16

Note: Total samples for all 3 stations = 86

Alternative Minimum Required Monitoring:

Although one sample per month would be adequate to demonstrate the Site's compliance status to EPA or CDPHE, there is a significant chance of declaring a false exceedance associated with smaller sample sizes. However, if budgets and priorities make the possibility of regulatory action preferable to the expense of the recommended sample sizes, then the Site may elect to gather samples as specified in Table 2-14 but analyze only one composite of those independent and sequential samples per month per station, and then perform additional analyses only if an exceedance is suggested in the composite and the historical mean for that AoI is below the action level at that monitoring station.

86

Several planning assumptions were adopted to estimate the minimum monitoring requirements for this high risk approach:

- Only one exceedance will be established for a single AoI at all three POEs in Segment 5, and the mitigation plan in response to that exceedance will establish increased work scope but no additional monitoring.
- Based on statistical evaluation, only Pu will exceed its action level. Thus, in the first month, Pu would incur one analysis from each station. No verification analyses would be performed because the historical average is greater than the action level. Therefore, the exceedance does not cause a change in the number of analyses during the first month.
- After the initial exceedance, only one sample per station per month would be taken.
- This one sample would be a composite that does not exceed a new criterion established by the mitigation plan.

The resulting projection of absolute minimum analytical requirements for Segment 5 is detailed in Table 2-15.[33]

[33] Note that this approach is contrary to the approach negotiated by the DOE, RFFO and approved during development of the IMP. This approach would incur significant risk of exceedances and regulatory response actions. Although Segment 5 may not be subject to penalties for exceedances, there would be increased risk of failure to notify, plan, schedule, and implement mitigating actions due to the much larger number of exceedances resulting from natural variability of single sample preparations and analytical results (rather than averages), combined with reduced resources and a smaller work force.

Table 2-15 Estimated Minimum Segment 5 Action Level Monitoring Requirements

Analyses	Sampling Protocol
Plutonium	**3(1+11) = 36**
Uranium	3 x 12 = 36
Americium	3 x 12 = 36
Beryllium	3 x 12 = 36
Chromium	3 x 12 = 36
Silver	3 x 12 = 36
Cadmium	3 x 12 = 36
Hardness	3 x 12 = 36
pH	Continuous
Conductivity	Continuous
Turbidity	Continuous
Nitrate	Continuous
Flow	Continuous

2.5 Monitoring Objectives for Terminal Detention Pond Discharges and Water Leaving the Site

This section covers all surface-water monitoring in streams leaving the eastern Site boundary (Indiana Street). This water is designated as Stream Segment 4a and/or 4b. This water is first monitored prior to discharge from the terminal ponds. Monitoring for RFCA compliance in Stream Segment 4 takes place at the terminal pond outfalls, and in both Woman and Walnut Creeks, near Indiana Street (RFCA POCs). Additional non-POC monitoring at Indiana Street has been identified by the working group and is described at the end of this section.

2.5.1 Predischarge Monitoring

As the Site moves into its accelerated cleanup, there is a possibility that new or increased levels of pollutants will be introduced into the pond systems from activities in the Industrial Area. The other monitoring objectives in this IMP are focused on specific analytes and indicators of greatest concern. Flow-paced monitoring of those parameters for pond inflows is comprehensive. However, some unusual contaminant could be overlooked by the other

88

monitoring objectives. It is important, therefore, to include a comprehensive analysis at some point, even when the historical data show no previous exceedances. The single sample predischarge monitoring is the least expensive method for including a comprehensive analytical suite in this IMP.

Under normal batch pond operations, nearly all water produced at the Site (including surface water runoff, treated effluents, and various approved process waste streams) is detained in one of three terminal ponds. The terminal ponds serve as the last control[34] point for the water before it leaves the Site.

For these reasons, predischarge monitoring is needed for a full range of constituents, including radionuclides, inorganics, and organics. Samples should represent the water to be discharged (i.e., grab samples should be depth integrated where applicable, and addition of water to the discharge should be minimized after the grab sample is taken). If the State of Colorado believes that the first sample is not representative of the discharge, the State may request, and the Site will provide, one additional predischarge sample if the discharge has not yet begun, or a during-discharge sample if the discharge is not yet complete. However, because of dam safety, the Site has sole discretion to determine the schedule for discharges, independent of any action the State may take with regard to predischarge monitoring. If the predischarge monitoring suggests an exceedance of a contaminant that is also monitored by flow-paced methods, the parties recognize that the flow-paced methods would be more representative of the discharge compliance status.

It is the intention of the parties that for predischarge monitoring the Site will perform the sample collection and that CDPHE will perform the laboratory analysis and reporting functions of the completed analytical data to the Site.

Data Types and Frequency:

> It is estimated that a total of 8-10 predischarge samples will be taken annually from the ponds in the Walnut Creek drainage and one sample per year is expected to be taken from Pond C-2 in the Woman Creek drainage. CDPHE will analyze the samples for an extensive list of constituents, including inorganics, metals, volatile organics, semivolatile organics, radiologic parameters, herbicides, and pesticides. The final list will be detailed in CDPHE's annual monitoring plan.
>
> This predischarge monitoring is limited to Ponds A-4, B-5, and C-2, or any other pond functioning as a terminal pond (e.g., Pond A-3 during construction in Pond A-4). Samples are intended to be taken far enough in advance of the discharge so that isolation, containment, flow-paced compliance monitoring (at the terminal pond outfall POCs), or other actions can be taken to mitigate an exceedance, but near enough to the time of discharge that the sample is representative of the discharge. It is the intent of all parties that sampling will be performed so that results are known prior to discharge.

[34] The Site's control over impounded water is quite limited. There are no treatment options readily available, and the detention time is limited by the capacity of the pond and the rate of influx from precipitation and other sources.

Decision Statement:

IF Predischarge monitoring results suggest apparent exceedances of the applicable stream standards—

THEN CDPHE may notify the Site of additional AoIs for that discharge.

- The Site would then perform flow-paced POC monitoring for the additional AoI(s) during the discharge, as part of the Segment 4 compliance monitoring (see Section 2.5.2); and
- The Site may evaluate other water management options, including but not limited to treatment, storage, or disposal, rather than immediate discharge.

It should be noted that the results of predischarge monitoring can only indicate an *apparent* exceedance because:

- The water sampled is impounded and not discharged at the time of sampling (the predischarge sampling protocol applies to water to be discharged); and
- The single grab predischarge sample does not necessarily reflect the quality associated with a 30-day moving average, against which nearly all standards are measured.

If an apparent exceedance is reported, DOE, RFFO has the responsibility to decide management alternatives. It is the intent of the parties that predischarge monitoring is not enforceable under RFCA, but it will be performed as a prudent management practice that all parties endorse.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - — Predischarge monitoring is a routine practice. It is unlikely that a discharge would occur without predischarge monitoring.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - — The parties intend that only one sample will be taken. No statistical sampling design is needed.

90

Monitoring Targets:

Monitoring analyses to be performed by CDPHE are shown in Table 2-16.

Table 2-16 Predischarge Monitoring Targets (Number of Samples/Analyses)

Analytical Parameter	Average Analyses per Month
Volatile organic analyses (502.2)	0.8
Chlorinated herbicide analyses (515.1)	0.8
Semivolatiles (525.2)	0.8
Selected Hazardous Substance List metals (total/total recoverable)	0.8
Selected Hazardous Substance List metals (dissolved)	0.8
Total dissolved solids	0.8
Total suspended solids	0.8
Nitrate/Nitrite as N	0.8
Nitrite as N	0.8

Table 2-16 (continued)

Analytical Parameter	Average Analyses per Month
Total phosphate	0.8
Orthophosphate	0.8
Ammonia	0.8
Sulfide	0.8
Gross alpha	0.8
Gross beta	0.8
Plutonium/uranium/americium	0.8
Tritium	0.8
pH	0.8
Dissolved oxygen	0.8
Conductivity	0.8
Totals	16.0

Note: Numbers of analyses are based on historical pond discharge operations.

2.5.2 Stream Segment 4/Point of Compliance Monitoring

RFCA provides specific standards for Walnut and Woman Creeks below the terminal ponds (Segment 4). These criteria and the responses to them are different than the criteria and actions associated with Segment 5. This section deals only with monitoring discharges from the terminal ponds into Segment 4 and the additional points of compliance for Segment 4 at Indiana Street. Terminal pond discharges will be monitored by POCs GS11, GS08, and GS31. Walnut Creek will be monitored at Indiana Street by POC GS03. Woman Creek will be monitored at Indiana Street by POC GS01. These locations are shown on Figure 2-4.

With the completion of the Woman Creek Reservoir, located just east of Indiana Street and operated by the city of Westminster, all Woman Creek flows will be detained in cells of the new reservoir until the water-quality has been assured by monitoring of Site discharges via Woman Creek at Indiana Street (at GS01). Reservoir water will then be pumped from Woman Creek Reservoir into the Walnut Creek drainage below Great Western Reservoir.

92

In the past, the majority of natural flow in Woman Creek was diverted to Mower Reservoir and did not exit the Site via Woman Creek. This is no longer the case; the Mower Ditch headgates have been upgraded, and all flows in Woman Creek will leave the Site via Woman Creek (at GS01) and enter the Woman Creek Reservoir. In the past, Pond C-2 (located off channel in the Woman Creek drainage) was predischarge sampled and subsequently pumped from Woman Creek into the Walnut Creek drainage on Site. Currently, the Site pump discharges Pond C-2 directly into Woman Creek (at GS31), which then flows to the Woman Creek Reservoir.

There is concern that meeting standards for radiologic parameters in Pond C-2 discharge does not adequately demonstrate that all water leaving the Site via Woman Creek and entering the Woman Creek Reservoir is meeting the radiologic standards. Other Woman Creek water (combined with Pond C-2 or flowing in the absence of any Pond C-2 water) will enter the Woman Creek Reservoir. This is the basis for setting an additional RFCA POC for Woman Creek at Indiana Street (GS01) for those radiologic contaminants that could be directly attributable to the Site (i.e., not naturally occurring).

A similar point of compliance, GS03, will be established at Walnut Creek and Indiana Street. Although the Walnut Creek drainage is not undergoing operational changes like those in Woman Creek, it is possible that contaminated overland runoff or landfill drainage may enter Walnut Creek below the terminal pond monitoring points (GS11 and GS08), yet upstream of Indiana Street.

Data Types and Frequency:

- RFCA AoIs, as sampled for Stream Segment 4 terminal pond discharges (see Table A-27 in Appendix A to this section).
- Isotopic Pu, Am, and tritium at Indiana Street POCs.
- Source(s) of the water sampled. Monitoring at Indiana Street POCs GS01 and GS03 calls for samples to be segregated based on water origin (natural creek flows or terminal pond discharges commingled with natural flows).
- Samples collected will be continuous flow-paced composites.
- Flow-paced monitoring is maintained at all times for all five POCs in Segment 4, even though no samples are anticipated from terminal pond stations except during planned pond discharges.

Terminal pond discharges currently occur approximately once per year for Pond C-2 and nine times per year for Ponds A-4 and B-5. Since the DQO process targeted 3 samples per discharge, terminal pond POCs currently target 30 composite samples to be collected annually.

During FY97, all routine North and South Walnut Creek water was discharged from Pond A-4. (Pond B-5 was pump transferred to Pond A-4 with the exception of IDLH operations requiring direct discharge of Pond B-5, see Section 2.2.1.) Terminal pond sampling protocols (3 sampled per batch discharge) were initially designed assuming that only Pond A-4 would discharge to

Walnut Creek.[35] Therefore, sampling protocols were modified for FY98/FY99 such that the number of continuous flow-paced composite samples to be collected annually for discharge from either Pond A-4 or Pond B-5 would be comparable to FY97. For fiscal years 1993 through 1997, the total combined discharge volume for Pond A-4 and Pond B-5 was 687 million gallons (Mgals) in 43 discharge batches, or 16 Mgals per discharge on average. Targeting three composite samples per discharge gives one composite sample per 5.3 Mgals of discharge volume. This modification will preserve the targeted sampling frequencies (based on discharge volume) while maintaining effective cost controls (based on total sample costs). For annual planning purposes, 9 samples will be collected from Pond A-4, and 18 from Pond B-5, resulting in the collection of the targeted 27 composite samples (see Table 2-19). However, this sample planning is dependent on the routing for the WWTP effluent. Any future changes in the management of Walnut Creek water could result is sampling protocol modifications while preserving the initial intent of the DQO process. For Pond C-2 discharges, three composite samples will be collected per discharge, regardless of volume.

The Indiana Street stations would generate the same number of samples during discharges, plus additional samples from storm runoff and baseflow between discharges. GS01 will collect three samples for the one expected Pond C-2 discharge, and storm runoff and baseflow samples based on average annual volumes. During storm runoff and baseflow, the target is one sample per 500,000 gallons, with a maximum of three samples during any one month (see Table 2-19). GS03 will collect the targeted 27 samples during Pond A-4 and Pond B-5 discharges (GS03 will collect the same number of composite samples as the terminal pond POCs for each discharge). During storm runoff and baseflow periods between discharges, GS03 will target 3 samples per period or 1 sample every 20 days, whichever is greater. The goal is to have at least two analytical results for any 30-day period for averaging purposes. The Site reserves the right to combine samples of the same flow pacing to save resources, as long as two sample results are available for any 30-day period. This sample frequency increase from FY97 for GS03 is a result of sampling protocol changes due to the occurrences of NSQ samples in FY97/FY98.

POC monitoring will be confined to Stream Segment 4 only, as represented by samples taken from the terminal pond discharges at GS11, GS08, and GS31, and the Indiana Street monitoring stations (GS01 and GS03). Table 2-17 shows the associations between monitoring locations and station designators.

[35] It is expected that Pond B-5 will be periodically direct discharged to Walnut Creek using the new outlet works. This discharge scenario is subject to agreement by the concerned parties.

94

Table 2-17 POC Monitoring Station Designators for Segment 4

Pond A-4	GS11
Pond B-5	GS08
Pond C-2	GS31
Walnut Creek at Indiana Street	GS03
Woman Creek at Indiana Street	GS01

Decision Statement:

IF The volume-weighted 30-day moving average[36] for any AoI in Stream Segment 4, as represented by samples from the specified RFCA POCs (i.e., terminal pond discharges and Indiana Street) exceeds the appropriate RFCA standard—

THEN RFCA requires that DOE, RFFO inform regulators within 15 days of DOE, RFFO gaining knowledge (not just a suspicion) that an exceedance (verified) has (actually) occurred:

- Notify EPA, CDPHE, and either Broomfield or Westminster, whichever is affected;
- Submit a plan and schedule to evaluate for source location, and implement mitigating action if appropriate; and
- The Site may receive a notice of violation.

Note that for the Indiana Street POCs, the only compliance monitoring to be performed is for Pu, Am, and tritium activity as measured at GS01 or GS03.[37]

[36] The 30-day average for a particular day is calculated as a volume-weighted average of a "window"of time containing the previous 30-days that had flow. Each day has its own discharge volume (measured at the location with a flow meter) and activity (from the sample carboy in place at the end of that day). Therefore, there are 365 30-day moving averages for a location that flows all year. At locations that monitor pond discharges or have intermittent flows, 30-day averages are reported as averages of the previous 30 days of greater than zero flow. For days where no activity is available, either due to failed laboratory analysis or NSQ for analysis, no 30-day average is reported.

[37] GS01 and GS03 are the POC monitoring stations for Woman Creek at Indiana Street, and Walnut Creek at Indiana Street, respectively.

95

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - The Site will attempt to gather at least one sample representative of each pond discharge event, and multiple sequential samples may be taken. Flow-proportional monitoring will be maintained at all times but may not be effective during dry periods when evaporative losses would invalidate the data, or when samples are inadequate for analysis due to a variety of operational problems.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - The decision error types and consequences for Segment 4 are presented in Table 2-18.

Table 2-18 Decision Error Types and Consequences in Segment 4

Error Type	Consequences
Failure to determine that an exceedance has occurred.	Potential for downstream water quality impacts.
Incorrect determination that an exceedance has occurred.	The Site would be required to provide notification, planning, a schedule, and response action that consumes limited resources when no exceedance has actually occurred, and the response would not be technically justifiable. The Site may also be subject to inappropriate fines or penalties or other regulatory action.

CDPHE and EPA representatives on the DQO team favored a simple decision rule that would be easier to explain to a concerned public. This led to a decision rule that placed equal emphasis on false alarms and failures to detect exceedances. The statistical design team recommended that the initial design be based on flow, and that this design should be reevaluated after flow-paced data become available.

Monitoring Targets:

Table 2-19 presents monitoring targets for Segment 4 POCs. The overall strategy is to sample each discharge as stated in the *Data Types and Frequency* text above. This plan assumes 8 samples per year from Pond A-4, 19 samples from Pond B-5, and 3 samples from Pond C-2. There is no storm or base flow immediately below the dams. At Walnut Creek and Indiana Street (GS03), the Site assumes that 27 samples will be collected annually during discharges from Ponds A-4 and B-5, and 2-3 samples of storm runoff and baseflow during the periods between discharges (approximately 28 samples). The Site will attempt to schedule discharges from Ponds A-4 and B-5 concurrently. Therefore,

96

approximately 10 discharge cycles per year will occur in Walnut Creek. At Woman Creek and Indiana Street (GS01), the Site plans to take three samples during one Pond C-2 discharge per year and a volume based number of samples each month for storm runoff and baseflow periods. The increase in storm runoff and base flow samples at GS01 over the initial FY97 targets is due to the new routing of Mower Ditch water to Woman Creek Reservoir and the corresponding increase in volume to be monitored. Note that the analyte lists for the terminal pond discharges are different than the analyte lists for the Indiana Street POCs.

Table 2-19 POC Monitoring Targets (Number of Samples/Analyses) for Segment 4 POCs

Time Period	Pond			Walnut Creek at Indiana Street	Woman Creek at Indiana Street	Total Number of Samples
	A-4	B-5	C-2			
During Discharge	9	18	3	27	3	60
Storm and Base Flow						
January	--	--	--	1	2	3
February	--	--	--	1	2	3
March	--	--	--	2	3	5
April	--	--	--	2	3	5
May	--	--	--	2	3	5
June	--	--	--	2	3	5
July	--	--	--	2	2	4
August	--	--	--	2	2	4
September	--	--	--	2	0	2
October	--	--	--	1	1	2
November	--	--	--	2	2	4
December	--	--	--	1	2	3
FY Totals	9	18	3	47	28	105

Note: -- = Not applicable FY = Fiscal year

97

2.5.3 Non-POC Monitoring at Indiana Street

The State of Colorado has proposed to conduct this non-POC monitoring as a prudent management action, and it is the intent of the RFCA parties that no enforcement action will be taken on the basis of this monitoring. There are several reasons to monitor for certain possible contaminants and nutrients in the water leaving the Site in both drainages. The actions to be taken on the basis of this monitoring are variable and may not be known until the monitoring results are available.

The CWQCC is moving toward waste load allocations for all segments of the Big Dry Creek drainage. Nutrient loadings generated by the Site are carried off Site via Walnut Creek, which either can bypass the Great Western Reservoir or be directed into the reservoir. Water bypassing the reservoir enters Segment 1 of Big Dry Creek, which then flows into the South Platte River. The Broomfield water replacement project will result in changes to the quantity and quality of water that could enter Great Western Reservoir. For these reasons, it will be necessary to monitor nutrient loads leaving the Site under all three of these conditions:

- Water leaving the Site via Walnut Creek that is 100% Site pond discharge (either originates as surface water on Site or is used and potentially contaminated by the Site before discharge from terminal ponds);
- Water leaving the Site via Walnut Creek is 100% stream flow and does not include pond discharge; and
- Water leaving the Site via Walnut Creek that is a mixture of Site discharge and stream flows.

With the changes in flow configuration in the Woman Creek drainage, there is a need to monitor to determine new ambient levels for various analytes at monitoring station GS01. The results of these analyses will be used to determine what changes in water quality, if any, have occurred as a result of the new flow configuration.

Data Types and Frequency:

The complete list of analytes (analyzed by CDPHE) are given in Table 2-20. The real-time parameters will be collected by the Site. Note that pH and temperature are needed to calculate un-ionized ammonia, and that the parties intend to drop monitoring for Be, Cd, Ag, and Cr in the future, unless FY98/FY99 monitoring results provide reasonable cause for concern. Nutrient analysis samples are grab samples. Un-ionized ammonia analyses are for samples from Walnut Creek at Indiana Street.

The source(s) of water at these locations during any sampling event must be identified.

Sample collection frequency will be as follows:

- Walnut Creek:
  - Five per year for 100% Site effluent (pond discharges),
  - Five per year for mixed effluent and natural stream flow, and
  - Five per year for 100% natural stream flow.
- Woman Creek:
  - Five per year not during Pond C-2 discharge, and
  - One per year during Pond C-2 discharge.

Non-POC monitoring is limited to Stream Segment 4, as represented by samples taken from Walnut Creek at Indiana Street and Woman Creek at Indiana Street (GS03 and GS01, respectively).

At different times, the water flowing off Site has differing composition of Site and natural stream flow. Samples will be scheduled so as to be representative of this variable composition.

Table 2-20 Non-POC Monitoring Requirements (Number of Samples/Analyses) at Indiana Street

Analyte	Number of Samples
Total ammonia	21
Nitrite	21
Nitrate	21
Total phosphate as P	21
Orthophosphate	21
Be, Cd, Ag, Cr	21
Isotopic uranium	21
pH	Continuous 15 min intervals
Temperature	Continuous 15 min intervals
Conductivity	Continuous 15 min intervals
Flow	Continuous 15 min intervals

Notes:
Five samples at each of the three flow mixtures in Walnut Creek, plus one Woman Creek sample during Pond C-2 discharge and five samples when Pond C-2 is not discharging: (5 x 3) + 1 + 5 = 21.
CDPHE will take their own grab samples independently for all nutrients, four metals, and U.

Ag= Silver
Be = Beryllium
Cd = Cadmium
CDPHE= Colorado Department of Public Health and Environment
Cr = Chromium
min= Minute
P = Phosphorous
POC= Point of compliance
U = Uranium

Decision Statement:

IF Concentrations or loadings of specified contaminants in Woman Creek exceed their 95% UTLs—

THEN CDPHE will notify the Site and cities, and the Site may propose a change in ambient standards.

No formal action has been identified as being dependent on nutrient monitoring of Walnut Creek at Indiana Street. The data may or may not be used in determining a waste load allocation for the Site in the future.

100

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
    - No special measures are needed beyond standard operating procedures.
- Acceptable Decision Error Rates for Statistical Sampling Design:
    - To be decided after variability is determined through FY98 monitoring.

Monitoring Targets:

One objective of FY98 nutrient load monitoring was to establish the variability of the data so that FY99/00 monitoring can be statistically designed. Three samples would be the absolute minimum required to estimate variability. Five samples for each parameter are planned. This monitoring is presented in Table 2-20.

2.6 Off-Site Monitoring Objectives: Community Water Supply Management

Contaminants generated by operations at the Site may have migrated off-Site and impacted the downstream reservoirs. In addition, D&D activities at the Site may increase the risk of environmental contaminant release. The potential for the public to be exposed to contaminants originating from the Site that can impact the community water supplies engenders public concern. Government officials in the downstream communities must respond to this public concern with adequate and timely monitoring data.

The ultimate decision regarding the management of community water resources rests with the affected community; however, monitoring data generated by other entities, such as CDPHE and the Site, are used to assess potential impacts, demonstrate acceptable water quality, and allay consumer concerns. These data are critical inputs for operational decisions.

2.6.1 Monitoring Uncharacterized Discharges

This monitoring would normally be required only if monitoring specified under the previous decision rules is not performed in accordance with the sampling and analysis protocols, e.g., Segment 4 POE or Segment 5 POC monitoring at Indiana Street, or if flow leaving the Site exceeds the capacity of the downstream ditches or reservoirs.

If surface water of unknown quality (unmonitored) leaves the Site, it is necessary to demonstrate that the water quality is acceptable to the downstream users. Examples include:

- Flow that has the potential to exceed the capacity of the Walnut Creek Diversion Ditch and enter Great Western Reservoir instead of being diverted around the reservoir; and
- Water quality in downstream waters that may have been impacted by unmonitored effluent from the Site.

Data Types and Frequency:

- Flow at the following monitoring locations:

  — Pond A-4: North Walnut Creek, GS11,

  — Pond C-2, GS31,

  — Pond B-5: South Walnut Creek, GS08,

  — Woman Creek at Indiana Street, GS01,

  — Walnut Creek at Indiana Street, GS03, and

  — McKay Ditch (currently monitored by temporary source location monitoring station GS35).

  Flow from these stations is needed to evaluate:

  — The potential for Walnut Creek to exceed the capacity of the Walnut Creek Diversion Ditch [estimated at 40 cubic feet per second (cfs)] and spill over into Great Western Reservoir, and

  — The relative contribution of various sources (ponds, storm drainages) to the total flow leaving the Site.

After the release event, water-quality data may be evaluated in combination with flow data to estimate the total impact. Note that the flow data will already be available from monitoring performed under other decision rules, assuming flow channel capacities are not exceeded.

- Water quality as follows:

  — Analytes are shown in Table 2-21.

  — Note: Constituents appearing on the "Short List" represent a minimum analyte list for all unplanned releases or discharges. Some or all of the constituents on the "Long List" may be necessary depending on the nature of the event, the source of the release, and the receiving water. The composition of either list may change depending on activities at the Site at the time of the event. Samples should be taken, but not necessarily analyzed, for all possibilities.

102

Table 2-21 Off-Normal Discharge Monitoring Inputs

Constituent Group	Short List	Long List
Radionuclides	Pu, gross alpha/beta (rapid turnaround indicator)	Gross alpha/beta, Pu, Am, U (isotopic), tritium
Physical properties and general water-quality measurements	pH, temperature, turbidity, TSS, conductivity or TDS	pH, temperature, turbidity, TSS, conductivity, TDS, hardness, alkalinity, fluoride, chloride, sulfate
Nutrients	Nitrate + nitrite	Nitrate, nitrite, ammonia (total and un-ionized), orthophosphate, total phosphorus
Organics	None	VOCs (EPA 524.2)
Metals	None	All metals having stream standards (As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Zn)

Notes:

Ag = Silver
Am = Americium
As = Arsenic
Be = Beryllium
Cd = Cadmium
Cr = Chromium
Cu = Copper
Fe = Iron
Hg = Mercury
Mn = Manganese
Ni = Nickel
Pb = Lead
Pu = Plutonium
Se = Selenium
TDS = Total dissolved solids
TSS = Total suspended solids
U = Uranium
VOC = Volatile Organic compound
Zn = Zinc

- Action levels:
  - Action levels would be the applicable CWQCC standard for the potentially impacted downstream segment (Segments 4a/b and 5).
- Sampling locations:

  Specific locations are event-driven, but may include:

  - Walnut Creek at Indiana Street, GS03,
  - Woman Creek at Indiana Street, GS01, or
  - Great Western Reservoir (only necessary if release of surface water enters Great Western Reservoir).

- Sampling frequency:
  - Event driven; only when uncharacterized water leaves the Site.
- Sample type:
  - Walnut and Woman Creeks at Indiana Street: If flow-paced composite sampling as specified under POC monitoring cannot be conducted, then grab samples will be collected as soon as the event is detected and every 4 hours thereafter until continuous monitoring is reestablished or the event terminates.
  - Reservoirs: Representative reservoir sampling will be conducted in accordance with the event and as agreed by the impacted parties. At a minimum, a surface composite sample, consisting of grab samples collected at various points in the reservoir, and a depth composite sample will be collected 48 hours after the event.

Geographically, this monitoring objective is bounded by the Walnut and Woman Creek basins, from the western Site boundary to the main stem of Big Dry Creek. However, the downstream communities are primarily concerned about the negative impact of contaminants leaving the Site on downstream reservoirs and water supplies; thus the monitoring locations of interest are:

- Woman Creek at Indiana Street, GS01;
- Walnut Creek at Indiana Street, GS03;
- Great Western Reservoir;
- Woman Creek Reservoir; and
- Mower Reservoir.

For this decision, monitoring would only be required when water of unknown quality leaves the Site. Under routine operations wherein surface water is under full management control of the Site, dam safety is not threatened, and POC monitoring is conducted as specified under Section 2.5.2, this monitoring is not needed.

Decision Statement:

IF	Surface water of unknown or unacceptable quality leaves the Site
THEN	The affected community will take appropriate protective measures until analytical data show that water quality is acceptable for the intended use.

104

For example, in the event of a contaminant release to Woman Creek Reservoir, Westminster might refrain from discharging water downstream until water quality has been analyzed and determined to be acceptable.

Acceptable Decision Errors:

Because this monitoring is event-driven, decisions regarding necessary and sufficient monitoring must be based on the nature of the event. Samples may be single grab samples, location composites, or time composites. Statistically-based sample sizes will not be used for development of this FY99/FY00 monitoring plan.

Monitoring Targets:

For planning purposes, no uncharacterized discharges are projected for FY99/FY00. If such a discharge does occur and this monitoring is needed, then the number and type of samples would be determined on a case-by-case basis.

2.6.2 Community Assurance Monitoring

RFETS' past mission as a nuclear weapons production facility, the nature of the contaminants, the history of releases and accidents, and the geographic and hydrologic relationship of the Site to the neighboring municipalities have made it necessary for the communities to reassure residents that their environment is safe. The level of concern fluctuates with activities at the Site but may be expected to continue as long as environmental contamination and special nuclear materials are present at the Site. Citizens' concerns are more effectively addressed by a routine monitoring program to measure the contaminants of concern at the locations of concern, than by institutional controls, modeling, and on-Site monitoring. The minimal community monitoring needed to provide this assurance is relatively inexpensive and demonstrates a community commitment on the part of DOE, RFFO. This community monitoring and Site monitoring are discussed at the Quarterly Information Exchange Meetings. The DOE, RFFO has also sponsored a dose reconstruction study for the Site.

Adequate and timely information regarding the impact of the Site on the neighboring environment is needed so that the communities can respond to citizens' concerns and the Site can foster a credible public image. Inadequate monitoring results in poor public relations, impaired trust, increased public resistance to proposed activities at the Site, *and increased mandatory monitoring*. The necessity for repeated public meetings and clean-up delays due to negative public comment may increase costs of operating the Site.

Data Types and Frequency:

- Sampling locations:
  - Since the completion of the Standley Lake Protection Project and the Great Western Reservoir Replacement Project, which were designed to protect the potable water supplies, routine monitoring of the municipal

105

treatment and distribution systems is no longer warranted. However, Great Western Reservoir is still used as an irrigation supply, and the fact that the reservoir is considered to be unsuitable for potable use raises questions on the part of irrigation customers. Ongoing assessment is needed to address these question.

— For FY99/FY00, Great Western Reservoir is the only sampling location needed.

- Sample types:

  — Quarterly depth-integrated composite samples are adequate to characterize the contaminant concentration in Great Western Reservoir.

- Sampling methods:

  — City personnel routinely conduct sampling in Great Western Reservoir and will collect the necessary samples for this objective as part of Broomfield's sampling program.

  — A sampling protocol acceptable to all parties will be developed and documented.

- Analytical methods:

  — Analytical methodology must be adequate to provide detection limits comparable to those reported by CDPHE since 1992—approximately 0.003 picocuries (pCi)/L for treated water and 0.006 pCi/L for raw water.

- Analyte list:

  This monitoring is limited to radionuclide contamination that is potentially attributable to the Site.

  — Pu-239/240,

  — Am-241,

  — U, isotopic (at least U-233/234:U-238), and

  — Tritium.

  The total number of samples needed for this monitoring objective would be four samples per year for FY99/FY00. The hydrologic regime for the Great Western Reservoir will change over time as the cities' irrigation and reuse projects are implemented. Sampling locations, types, and frequencies will be reevaluated to reflect these changes.

1066

Decision Statement:

IF	The potential for public exposure to contaminants attributable to the Site causes reasonable concern in the neighboring communities—
THEN	Monitoring to quantify contaminant concentrations and provide the necessary information must be performed.

The response to a significant change in contaminant levels would be a different decision. The monitoring objectives described in previous sections are designed to prevent increased concentrations in the community drinking water systems. These community assurance monitoring data are used to address routine inquiries and to respond to occasions of unusual public concern. The data have been needed in the past and should be considered in future planning.

Acceptable Decision Errors:

Sufficient sampling and analysis must be performed to provide credible assurance that community water quality is adequately monitored and understood. A high level of confidence that the monitoring meets the desired objective is necessary. Because the type of monitoring involved is inconsistent with multiple samples, the required certainty must be achieved through appropriate sampling procedures, adequate sample volumes, laboratory quality control, and good analysis validation protocols.

Monitoring Targets:

Monitoring requirements for this section are presented in Table 2-22.

Table 2-22 Monitoring Targets (Number of Samples/Analyses) for Community Assurance Monitoring

Analyte	Analyses for FY98/FY99	
	Great Western Reservoir (Analyses per year)	Total
Pu-239/240	4	8
Am-241	4	8
U, isotopic[38]	4	8
Tritium	4	8

Notes:

Am	=	Americium	Pu	=	Plutonium
FY	=	Fiscal year	U	=	Uranium

2.7 WATERSHED INTEGRATION

Geographically, the RFETS lies at the head of the Big Dry Creek Basin; functionally, every effort has been made to isolate the Site from the rest of the watershed. Historical strategies on the part of both the Site and the downstream communities have focused on limiting, to the maximum extent possible, the natural flow of surface water from the Site. Examples include past spray irrigation practices, the "Zero Discharge" goal, and the continuing detention of treated sanitary effluent and stormwater pending demonstration of acceptable water quality. Although these water management practices have been necessary to protect and reassure the downstream communities, they negatively impact the ecology of the basin and are inconsistent with the ultimate vision for the Site, as outlined in RFCA. As Rocky Flats moves toward closure, the focus must evolve toward integrating the headwaters of Big Dry Creek with the rest of the watershed.

To accomplish this objective, the Site must extend it's water management strategy beyond Indiana Street, and participate with other stakeholders in identifying and implementing appropriate water quality and use goals for the basin. During 1996, DOE and it's contractors progressed toward this goal by actively participating in a consensus group with the objective of achieving agreement on as many issues as possible prior to a standard-setting hearing before the CWQCC. The group included representatives from the RFETS, regulatory agencies and surrounding communities, but limited it's focus to water quality issues impacting wastewater dischargers.

[38] Total U and U-233/234:U-238 ratio, as a minimum.

108

More recently, Site personnel helped to establish the Big Dry Creek Watershed Association (BDCWA), which began as an extension of the original consensus group, but has evolved to include any entities or individuals interested in water-related issues within the basin. In addition to the original four dischargers, participants include representatives of agriculture, parks, recreation, open space, and a variety of government agencies. The BDCWA has bee recognized by DRCOG as a district watershed in the Regional Clean Water Plan. The goals the Association include public education, monitoring activities, and protection of water quality, aquatic life and habitat.

The DOE has recognized the effectiveness of this approach by becoming a Party to a formal Agreement to participate, with the Cities, in supporting monitoring activities within the basin. The Agreement states that such support may consist of monetary contributions or in-kind services, but shall be equitably distributed among the Parties. Monitoring decisions are made jointly by the group, with input from regulators and planning agencies including EPA, the WQCD and DRCOG. The immediate use of the data is to characterize the watershed and to identify and quantify any sources of impairment. Ultimately, water quality and biological data will be used to support water-quality standards, native species protection, and basin-wide planning activities. A coordinated effort to obtain accurate information about existing conditions and relative impacts is beneficial and cost effective for all Stakeholders.

Data Types and Frequency:

The type of data needed and frequency of collection may vary as the watershed characterization progresses, and by agreement among the Stakeholders, but will include habitat assessment and biological sampling. Water-quality data collection downstream of the Site boundary is not currently funded by the Site, but if analysis of the biological data identifies a need for additional water-quality information, the necessary analyses may be included in future revisions of this document.

- Sampling Locations

  Various (6) sites along Walnut Creek, from the eastern Site boundary at Indiana Street to the confluence with the mainstem of Big Dry Creek.

- Sampling and Analytical Methods

  The sampling, analysis, and data interpretation protocols must be consistent with those selected for the downstream sites monitored by the Cities.

- Analyte List

  - Fish population
  - Macro-invertebrate population
  - Habitat assessment
  - Flow

- Water quality, if needed (constituents based on drivers).

Decision Statement:

IF	Impairments to Big Dry Creek are identified,
AND	RFETS activities are suspected to have adverse impact on water quality or habitat,
THEN	The Site may be required to address these impacts through more stringent NPDES permit limitations, flow controls, habitat protection or restoration requirements, or other regulatory controls.

If the relative impact of factors such as stormwater, WWTP discharges, agriculture, irrigation deliveries and diversions, and urbanization have not been adequately characterized, the Site may face large expenditures for capital improvements, environmental mitigation, and litigation that will not result in a significant improvement to the stream.

Acceptable Decision Errors:

For biological sampling, the sampling and analysis protocols have been designed to allow an assessment of certainty.

Monitoring Targets:

Anticipated monitoring requirements for this objective are listed in Table 2-23.

Table 2-23 Anticipated Monitoring Requirements for Watershed Integration

Constituent	Frequency	Total Number of Samples FY99-00
Habitat Assessment	Annual	1
Flow	Concurrent with biological sampling	2
Fish population	Semi-annual, spring and fall	2
Invertebrate population	Semi-annual, spring and fall	2
Water Quality	As needed	None projected

110

2.8 REFERENCES

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112

APPENDIX A

Additional Tables

APPENDIX A

Additional Tables

List of Tables

114

Table A-24
40 CFR 122 Appendix D Analytes for Internal Waste Stream Characterization

Table I-Conventional Pollutants

Total suspended solids (TSS)	pH
Total dissolved solids (TDS)	Total Kjeldahl nitrogen
Chemical oxygen demand (COD)	Nitrate plus nitrite
5-day biological oxygen demand (BOD5)	Dissolved phosphorus
Oil and grease	Total ammonia plus organic nitrogen
Fecal coliform	Total phosphorus
Fecal streptococcus	

Table II-Organic Toxic Pollutants in Each of Four Fractions in Analysis by Gas Chromatography/Mass Spectroscopy (GS/MS)

Volatiles

acrolein	dichlorobromomethane	1,1,2,2-tetrachloroethane
acrylonitrile	1,1-dichloroethane	tetrachloroethylene
benzene	1,2-dichloroethane	toluene
bromoform	1,1-dichloroethylene	1,2-trans-dichloroethylene
carbon tetrachloride	1,2-dichloropropane	1,1,1-trichloroethane
chlorobenzene	1,3-dichloropropylene	1,1,2-trichloroethane
chlorodibromomethane	ethylbenzene	trichloroethylene
chloroethane	methyl bromide	vinyl chloride
2-chloroethylvinyl ether	methyl chloride	
chloroform	methylene chloride	

Table III-Other Toxic Pollutants (Metals and Cyanide) and Total Phenols

Antimony, Total	Chromium, Total	Nickel, Total	Zinc, Total
Arsenic, Total	Copper, Total	Phenols, Total	Cyanide, Total
Beryllium, Total	Lead, Total	Silver, Total	Selenium, Total
Cadmium, Total	Mercury, Total	Thallium, Total	

Table IV-Conventional and Nonconventional Pollutants Required to be Tested by Existing Dischargers if Expected to be Present

Bromide	Nitrogen, Total Organic	Surfactants	Molybdenum, Total
Chlorine, Total	Oil and Grease	Aluminum, Total	Manganese, Total
Residual	Phosphorus, Total	Barium, Total	Tin, Total
Color	Radioactivity	Boron, Total	Titanium, Total
Fecal Coliform	Sulfate	Cobalt, Total	
Fluoride	Sulfide	Iron, Total	
Nitrate-Nitrite	Sulfite	Magnesium, Total	

Table V-Toxic Pollutants and Hazardous Substances Required to be Identified by Existing Dischargers if Expected to be Present

Toxic Pollutants

Asbestos

Hazardous Substances

Acetaldehyde	Disulfoton	Phosgene
Allyl alcohol	Diuron	Propargite
Allyl chloride	Epichlorohydrin	Propylene oxide
Amyl acetate	Ethion	Pyrethrins
Aniline	Ethylene diamine	Quinoline
Benzonitrile	Ethylene dibromide	Resorcinol
Benzyl chloride	Formaldehyde	Strontium
Butyl acetate	Furfural	Strychnine
Butylamine	Guthion	Styrene
Captan	Isoprene	2,4,5-T (2,4,5-Trichlorophenoxy acetic acid)
Carbaryl	Isopropanolamine	TDE (Tetrachlorodiphenylethane)
Carbofuran	Dodecylbenzenesulfonate	2,4,5-TP [2-(2,4,5-Trichlorophenoxy) propanoic acid]
Carbon disulfide	Kelthane	Trichlorofan
Chlorpyrifos	Kepone	Triethanolamine dodecylbenzenesulfonate
Coumaphos	Malathion	Triethylamine
Cresol	Mercaptodimethur	Trimethylamine
Crotonaldehyde	Methoxychlor	Uranium

\\\6

Hazardous Substances (Continued)

Cyclohexane	Methyl mercaptan	Vanadium
2,4-D (2,4-Dichlorophenoxy acetic acid)	Methyl methacrylate	Vinyl acetate
Diazinon	Methyl parathion	Xylene
Dicamba	Mevinphos	Xylenol
Dichlobenil	Mexacarbate	Zirconium
Dichlone	Monoethyl amine	
2,2-Dichloropropionic acid	Monomethyl amine	
Dichlorvos	Naled	
Diethyl amine	Napthenic acid	
Dimethyl amine	Nitrotoluene	
Dintrobenzene	Parathion	
Diquat	Phenolsulfanate	

Notes:
CFR = *Code of Federal Regulations*

117

Table A-25
Operational Limitations on Influent to WWTP

No person shall discharge or cause to be discharged to the sanitary sewer any stormwater, surface water, groundwater, roof runoff, subsurface drainage, cooling water, air conditioning wastewater, or any other domestic, commercial or industrial wastewater not meeting the following limitations:	
1	Must have an instantaneous pH value in the range of five (5.0) to ten (10.0) standard units.
2	Must not contain any solid, viscous or liquid wastes which allow or may cause obstruction to the flow in a collection line or otherwise interfere with the proper operation of the WWTP. Prohibited materials include all solid objects, material, refuse, and debris not normally contained in sewage.
3	Must not contain explosive mixtures consisting of liquids, solids, or gases which by reason of their nature or quantity are, or may be, sufficient either alone or by interaction with other substances to cause fire or explosion or be injurious in any way to the operation of the WWTP. At no time shall two (2) successive readings on an explosion hazard meter at the point of discharge into the wastewater system be more than five percent (5%), nor may any single reading be over ten percent (10%) of the lower explosive limit (LEL) of the meter. Prohibited materials include, but are not limited to: gasoline, kerosene, naphtha, benzene, toluene, xylene, ethers, alcohols, ketones, aldehydes, peroxides, chlorates, perchlorates, bromates, carbides, hydrides and sulfides.
4	Must not contain any flammable substance with a flashpoint lower than 186 degrees F.
5	Must have a temperature between 32 degrees to 150 degrees F.
6	Must not contain grease or oil or other substance that will solidify or become viscous between 32 degrees and 150 degrees F.
7	Must not contain improperly shredded garbage that has not been ground or comminuted to such a degree that all particles will be carried freely in suspension under flow conditions normally prevailing in the wastewater system to which the user is connected. At all times, no particle shall be greater than one-half inch (½) in any direction.
8	Must not contain gases or vapors either free or occluded in concentrations toxic or dangerous to humans or animals.
9	Must not contain any pollutant, including oxygen demanding pollutants (BOD5, etc.) released at a rate and/or concentration which has a reasonable potential, in the opinion of the WWTP manager, to adversely affect the WWTP (inhibition, pass-through, sludge contamination, or endangerment of the WWTP operators).
10	Must not contain any toxic or irritating substance which will create conditions hazardous to public health and safety.
11	Must not contain in excess of 100 ppm of any grease or oil or any oily substance from

118

	petroleum or mineral origin, or both, including but not limited to: a) cooling or quenching oils; b) lubrication oil; c) cutting oils; and d) non-saponifiable oils.
12	Must not contain toxic or poisonous solids, liquids or gases in sufficient quantity, either singly or by interaction with other wastes, to injure or interfere with any sewage treatment process, to create any hazard in the receiving waters of the WWTP or to contaminate the sludge of any wastewater treatment process.
13	Must not cause the temperature of the treatment plant to exceed 40 degrees C (104 degrees F).
14	Must not contain organic toxic pollutants, introduced by the intentional or accidental dumping of solvents, used in operations involving degreasing, surface preparation, tank washing, paint thinning, paint equipment cleaning or any other process.
15	Must not contain any hazardous waste, either listed or characteristic.
16	Numerical guidelines. See Allowable Concentrations worksheet.

Notes:

C	=	Celsius
F	=	Fahrenheit
LEL	=	Lower explosive limit
ppm	=	parts per million
WWTP	=	Wastewater treatment plant

Table A-26
RFCA Analytes of Interest for Segment 5

RFCA Attachment 5, Table 1 specifies additional limitations beyond those specified here, and all RFCA Table 1 contaminant limitations are applicable. But most of those contaminant limitations are not exceeded and pose hypothetical health risks well below a 10^{-6} criterion, and are not a threat to the environment. Those contaminants do not need to be monitored. The analytes of interest (AoIs) specified here are the analytes for which monitoring funds will actually be requested.

Assumptions:

These AoIs were developed and agreement achieved on the basis of the assumptions below. These assumptions allow all parties to agree that funding and resources should be focused on this relatively short list of contaminants for which there is reasonable cause to expect exceedances of RFCA standards and action levels.

- Discharges into Segment 4 will be from batch operations as currently conducted.
- Sampling for Segments 4 and 5 RFCA compliance will be flow-proportional.
- Predischarge sampling by CDPHE will be comprehensive.
- Cost effective analytical methods used to monitor the AoIs will also yield information about other potential, but unanticipated, contaminants.
- The Site will perform tritium monitoring in Segment 4 at the Indiana Street Point of Compliance.
- Any of the parties may, from time to time, identify additional AoIs for cause, for a specific discharge event. If the parties agree, additional contaminants may be added to the ongoing AoIs specified here.

Table A-26
(continued)

Segment 5 Analytes Of Interest The signatory parties to this plan agree that the AoIs for Segment 5 main stream channel monitoring stations are those listed below.		
Radionuclides:	Pu 239, 240	High level of public concern. Known carcinogen. Known past releases (within the past 8 years) have exceeded RFCA stream standards and action levels. This provides reasonable cause to expect future releases in excess of RFCA action levels.
	U 233, 234, 235, 238	Known renal toxicity. Present on Site. Past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	Am 241	Known carcinogen. Present on Site. Known past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
Metals:	Be	Known to cause berylliosis in susceptible individuals when exposed by inhalation. May also cause contact dermatitis. Present on Site. Will be monitored as an indicator of releases from process and waste storage areas.
	Cr	Physiological and dermal toxicity. High level of regulatory concern due, in part to the chromic acid incident of 1989. Low levels can cause significant ecological damage.
	Ag (dissolved)	Highly toxic to fish at low levels if chronic. State of Colorado has temporarily removed its stream standard for silver, while under study. The study has been completed, and the standard will be reinstated at the next triennial review of South Platte stream standards, if not before. Used on Site only for photographic development. Routinely accepted by POTWs as municipal waste, but discharge is regulated. May be removed from this list later if data do not support concern.

121

Table A-26
(continued)

Metals (Continued)	Cd (dissolved)	Highly toxic to fish at low levels if chronic. Known human carcinogen (prostate cancer) and depletes physiologic calcium. Used on Site in plating processes. Monitoring data for the Interceptor Trench System (ITS) and the proposed discharge of untreated ITS waters into Walnut Creek provide reasonable cause to expect future releases in excess of RFCA action levels.
	Hardness	Required to evaluate metals analyses due to its effect on solubility of these metals.
Real Time Monitoring of Physical and Indicator Parameters: These parameters provide real-time indication for a wide variety of regulated contaminants and are also a required component of monitoring for AoIs. They require no laboratory analyses and are the Site's most cost effective defensive monitoring.	pH	Toxicity to humans and ecology. Regulatory concern due to chromic acid incident. Real-time monitoring is inexpensive and effective method of detecting acid spills such as (chromic acid or plutonium nitrate) or failure of treatment systems.
	Conductivity	Conductivity is an indicator of total dissolved solids, metals, anions, and pH. Real-time monitoring of conductivity is an inexpensive indicator of overall water quality.
	Turbidity	Turbidity is a general indicator of elevated contaminant levels and may be correlated with Pu.
	NO_3	Past releases near RFCA stream standards and action levels upstream of ponds provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels. ITS discharges are often high in nitrate and may challenge RFCA action levels.
	Flow	Required to detect flow events, evaluate contaminant loads, and plan pond operations and discharges. Affects nearly every decision rule and is the most commonly discussed attribute of Site surface waters.

Notes:

VOAs, Fe, and Mn are specifically excluded from this list. The parties recognize that VOAs will not be effectively monitored at these monitoring stations, and defer to the decision rules that drive monitoring closer to the sources of VOA contamination.

AoI = Analytes of interest
Ag = Silver
Am = Americium
Be = Beryllium

122

Table A-26
(continued)

Cd	=	Cadmium
Cr	=	Chromium
Fe	=	Iron
ITS	=	Interceptor Trench System
Mn	=	Manganese
NO_3	=	Nitrate
POTW	=	Publically owned treatment works
Pu	=	Plutonium
RFCA	=	Rocky Flats Cleanup Agreement
U	=	Uranium
VOA	=	Volatile organic analysis

Table A-27
RFCA AoLs for Segment 4

Segment 4 Analytes Of Interest This extremely focused list of AoIs was developed and agreed upon based on the following assumptions: • The Site will perform Segment 5 monitoring for the AoIs described in Table A-26. • CDPHE will perform comprehensive monitoring, including tritium, for the predischarge samples.		
Terminal Pond Discharge Monitoring POCs		
Radionuclides:	Pu 239, 240	High level of public concern. Known carcinogen. Known past releases (within the past 8 years) have exceeded RFCA stream standards and action levels. This provides reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	U 233, 234, 235, 238	Known renal toxicity. Present on Site. Past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	Am 241	Known carcinogen. Present on Site. Known past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
Real-Time Monitoring of Physical and Indicator Parameters: These parameters provide real-time indicators for a wide variety of regulated contaminants and are also a required component of monitoring for AoIs. They require no laboratory analyses and are the Site's most cost effective defensive monitoring.	pH	Toxicity to humans and ecology. Regulatory concern due to chromic acid incident. Real-time monitoring is inexpensive and effective method of detecting acid spills such as (chromic acid or plutonium nitrate) or failure of treatment systems.
	Conductivity	Conductivity is an indicator of total dissolved solids, metals, anions, and pH. Real-time monitoring of conductivity is an inexpensive indicator of overall water quality.
	Turbidity	Turbidity is a general indicator of elevated contaminant levels and may be correlated with Pu.
	NO_3	Past releases near RFCA stream standards and action levels upstream of ponds provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels. ITS discharges are often high in nitrate and may challenge RFCA action levels.

124

Table A-27
(continued)

Terminal Pond Discharge Monitoring POCs		
Real-Time Monitoring of Physical and Indicator Parameters (continued)	Flow	Required to detect flow events, evaluate contaminant loads, and plan pond operations and discharges. Affects nearly every decision rule and is the most commonly discussed attribute of Site surface waters.
Indiana Street Monitoring POCs		
Radionuclides:	Pu 239, 240	High level of public concern. Known carcinogen. Known past releases (within the past 8 years) have exceeded RFCA stream standards and action levels. This provides reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	Am 241	Known carcinogen. Present on Site. Known past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	Tritium	Tritium is an AoI for the cities due to the past release of tritium (1973).
Real Time Monitoring:	--	Indiana Street is not a point of compliance for the real-time monitoring parameters.

Note:
Non-POC monitoring specified in Table 2-21 is not reflected in this table, because the parties intend that Indiana Street not be a POC for the parameters.

--	=	Not applicable
AoI	=	Analytes of interest
Am	=	Americium
ITS	=	Interceptor Trench System
NO_3	=	Nitrate
POC	=	Point of compliance
Pu	=	Plutonium
RFCA	=	Rocky Flats Cleanup Agreement
VOA	=	Volatile organic analysis
U	=	Uranium

125

Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

Groundwater Monitoring

September 1999

126

Table of Contents

List of Figures

Page

128

List of Plates

List of Tables

3.0 GROUNDWATER MONITORING

3.1 Introduction

This section of the *Integrated Monitoring Plan* (IMP) describes the groundwater monitoring requirements for Rocky Flats Environmental Technology Site (RFETS or the Site) as outlined in the *Rocky Flats Cleanup Agreement* (RFCA) [Department of Energy (DOE et al.), 1996], and how they will be implemented at the Site. All RFETS groundwater monitoring is performed by Site organizations because groundwater contaminant plumes occur within the Site boundaries. Therefore, this IMP covers all groundwater monitoring activities. After a brief history of the monitoring program, this section outlines the goals for groundwater monitoring and describes quality assurance/quality control (QA/QC) components and monitoring components. To evaluate groundwater monitoring needs, one must know the RFCA action levels for groundwater, Site history and areas of contamination, the physical and hydrologic setting of the Site, the effect of contaminated areas on groundwater, and the nature of the groundwater contaminant plumes. This information is presented in Appendices A, B, C, and D to this Groundwater Monitoring section, respectively. Appendix E lists the wells that will be monitored for water quality or for groundwater flow.

3.1.1 Purpose of the Integrated Monitoring Plan for Groundwater

In the past, two plans have been required at the Site to comply with DOE Order 5400.1 (DOE, 1988), a "Groundwater Protection Management Program Plan," and a "Groundwater Monitoring Plan." These two plans have historically been combined into one document, the *Groundwater Protection and Monitoring Program Plan* (GPMPP) (EG&G, 1993a), which defines and describes the groundwater protection and monitoring programs at the Site. In addition, an assessment groundwater monitoring plan was required under the Resource Conservation and Recovery Act (RCRA) for the interim status units on Site. This plan is called the *Final Groundwater Assessment Plan* (GWAP) (DOE, 1993). Other monitoring plans have been developed to address groundwater monitoring requirements as outgrowths of various Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Interim Measure/Interim Remedial Action (IM/IRA) decision documents. This portion of the IMP will serve as the Groundwater Monitoring Plan for the Site, and it will replace the requirements found in the group of plans named above. It will also revise the requirements of the routine groundwater monitoring portion of the Industrial Area IM/IRA decision document (DOE, 1994a) and the French Drain IM/IRA plan (DOE, 1992a).

3.1.2 Brief History of Groundwater Monitoring Activities

The historic growth of the groundwater monitoring network at the Site reflects the increasing DOE, regulatory, and public emphasis on identifying areas of groundwater contamination and preventing contaminant releases to the environment. The first three monitoring wells were installed in 1954 in the Solar Ponds area. A total of 1,055 wells and piezometers were installed at the Site from 1971 to present. Plate 1 shows all the wells that have been installed at the Site since 1974.

Wells in the groundwater monitoring network were sampled annually until 1974, twice a year until 1980, and three times a year during 1981. From 1982 to 1995, designated monitoring wells were sampled quarterly. Beginning in 1995, designated wells were sampled either quarterly or semiannually, depending on regulatory requirements. The wells to be sampled are determined by the types of wells (e.g., RCRA), and the areas being monitored. Currently, wells are sampled on a semiannual basis. The groundwater monitoring program has supported the following compliance programs at the Site:

- RCRA programs;
- CERCLA programs;
- The Background Groundwater Characterization Program (completed in 1993);
- The Boundary Well Monitoring Program;
- Groundwater Protection (DOE Order 5400.1);
- French Drain IM/IRA Performance Monitoring Program;
- Industrial Area IM/IRA Monitoring Program;
- New Sanitary Landfill Permit Monitoring Program; and
- Special activities that support hydrogeologic projects, including aquifer testing and hydrogeological characterization.

Groundwater has been monitored for radionuclides since the first wells were installed in 1954; other chemical analytes were added in 1974, 1979, 1981, 1985, and 1994. Beginning in 1985, the wells were sampled and analyzed for volatile organic compounds (VOCs), metals, and major anions. Limited analyses for pesticides have also been performed. Results of groundwater analyses from 1986 to present are compiled in the Site Soil and Water Database (SWD).

In 1993, the large number of wells that were being monitored as an outgrowth of the various remedial investigations at the Site prompted the Well Evaluation Project. The *Well Evaluation Report* (WER) (EG&G, 1994c) reduced the monitoring network from 460 wells to 350 wells, but retained those wells in or near contaminant plumes.

In 1995, the Well Evaluation Project updated plume maps and again evaluated the monitoring network. On the basis of new plume configurations, the number of wells monitored was reduced from 350 wells to 150 wells, and the sample frequency and analyte list were amended.

131

3.1.3 Current Status of the Groundwater Program

In July 1996, the RFCA was approved (DOE, 1996). RFCA replaces the Interagency Agreement (IAG) as the environmental cleanup agreement for the Site. RFCA outlines the goals, objectives, and strategies that will lead to the Site cleanup and closure mission objectives. Supporting activities will reduce, eliminate, or mitigate existing environmental liabilities while maintaining the Site in a safe condition. The Action Levels and Standards Framework (ALF) portion of RFCA contains specific requirements for monitoring and reporting, and it sets action levels for contaminant concentrations in groundwater and in other media (see Appendix B to this section). The IMP is required under RFCA to further define the monitoring programs for the Site.

Defining the groundwater monitoring involved reevaluating the monitoring system to ensure that it was protective of the environment, compliant with all applicable regulations and agreements, and aligned with the new Site mission. A data quality objective (DQO) process was used to determine the function of each well in the network and the decisions supported by information from each well. The DOE, Rocky Flats Field Office (DOE, RFFO), the Colorado Department of Public Health and Environment (CDPHE), and the U.S. Environmental Protection Agency (EPA) stakeholders were directly involved in all decisions about the monitoring network. Results of this evaluation are presented starting in Section 3.2.

3.1.4 Groundwater Interactions with Surface Water

There is considerable interchange between surface water and groundwater at Rocky Flats. Interchange occurs along stream channels, ponds, ditches, and lakes by way of natural hillside and channel seepage and artificial flow control structures, such as foundation drains and dams, that interrupt the natural flow of water. Streams nearest to the Industrial Area are more likely to be contaminated by groundwater discharges and, thus, have traditionally been the focus of most groundwater monitoring.

As shown in Figure 3-1, three ephemeral streams drain the Site. The streams are Rock Creek, Walnut Creek (consisting of three tributaries, "No Name Gulch," Walnut Creek, and South Walnut Creek), and Woman Creek. Groundwater is discharged from the Rocky Flats Alluvium and other surficial deposits through surface seeps and subsurface flow that, in turn, recharge stream flow and the stream valley groundwater system. Segments of streams have been shown to either gain or lose water as groundwater is discharged to or stream water is discharged from the stream channel. Gaining reaches of streams are more likely to be contaminated by groundwater discharges.

3.1.5 General Strategy for Groundwater Plume Management and Remediation

The existence of groundwater contaminant plumes (e.g., volatile organic, radionuclide, nitrate) at RFETS has been well documented. The *Groundwater Conceptual Plan for the Rocky Flats Environmental Technology Site* (RMRS, 1996) presented a summary of the known information on individual groundwater plumes and possible remedial actions. The plume management template below outlines the process for decision making for the management and remediation of plumes at the Site. This template serves as a unifying policy for plume management and decision making for groundwater plumes under the IMP and aids in the integration of groundwater functions at the Site.

The plume management strategy for RFETS will consist of the following components:

- Phase 1: Detection Monitoring:

  The IMP gives DQOs that establish the methods of detection monitoring in groundwater and the actions that will follow. The detection of groundwater contamination that could impact surface water at RFETS will be supported through the current water monitoring programs at RFETS as well as through historic data from past investigations and information on past contaminant spills. The surface and groundwater monitoring programs have been established to detect the migration of contaminants in water on Site that could have the potential to move off Site. The monitoring programs are dynamic and may be changed to accommodate new insights into contaminant migration. The Soil Water Database and the *Final Historic Release Report for the Rocky Flats Plant* (HRR) (DOE, 1992b) are the main repositories for information on groundwater contamination, and both are updated on a regular basis with new data. The Quarterly RFCA Groundwater Reports present data generated from the groundwater monitoring under the IMP. Exceedances of action levels are also identified and discussed in these reports.

- Phase 2: Plume Evaluation

  Plume evaluations to determine the potential for groundwater contamination to impact surface water are triggered by reportable exceedances of action levels as defined in the IMP and as reported in the Quarterly RFCA Groundwater Report. As stipulated in the ALF, the evaluation is predicated on the confirmatory sampling that follows an exceedance of groundwater action levels. The evaluation phase initiates a DQO assessment to determine the data needed to evaluate the nature of groundwater contamination to surface water. The following are possible components of an evaluation of surface water impact as determined by plume specific DQOs:

B4

— Source identification and contaminants of concern,

— Plume extent through determination of pathway linear and areal extents by subsurface correlation of saturated thickness and permeable lithologies,

— Recharge and discharge through quantification of water balance, flow velocity, gradient and direction for groundwater,

— Concentration loadings and mass flux of contaminants to surface water, and

— Effects due to seasonal variations, natural attenuation of contaminants or changes in discharge due to construction/removal of containment structures, treatment systems or removal of sources.

Decisions with respect to plume evaluations will involve the groundwater working group. Results of the plume evaluations will be used to update the environmental restoration (ER) ranking process under RFCA to ensure that the available budget will be allocated to areas with the highest potential for contamination.

- Phase 3: Alternatives Analysis:

If a significant impact to surface water has been established, evaluation findings will be used to establish various options for present and long term management of the contamination. These options may include remedial actions or a long-term monitoring strategy to evaluate whether the nature and extent of contamination will change with time. The decision analysis step may include:

— Evaluation of remedial/management alternatives (per the nine CERCLA evaluation criteria) including the no action alternative,

— Determination of DQOs to support the alternative selected, and

— Consideration of practical implications of each alternative including compatibility with other Site closure activities and potential impact to the ecology and environment.

Alternatives will involve discussion with the groundwater workgroup during key phases of the process. Once an alternative has been selected, a remediation/ management project will be developed with its own scope, schedule and budget. The project will result in a decision document which will include the choice of

135

alternatives, public review and an outline of the remedial design/construction and/or monitoring actions that are necessary.

- Phase 4: Remedial Design/Construction:

  If a remedial action decision has been reached, additional information may be needed to aid in the design and construction of a remedial system. A data quality objective process will be employed to establish the decision and data needs to aid in the construction of the remedial system. The remedial system may consist of a groundwater containment or treatment system, or a source removal action. Components of this step may include:

  — Preparation and presentation of design documents and construction workplans,

  — Preparation and presentation of additional sampling and analysis plans,

  — Determination of performance monitoring requirements, and

  — Alternatives will involve discussion with the groundwater workgroup during key phases of the project.

- Phase 5: Remedial Decision Validation:

  Additional groundwater monitoring may be required to validate the efficacy of a remedial action or the no-action alternative. Performance monitoring will consider both the short term and the long term protection of surface water. A DQO process will be employed to establish a performance monitoring system. Decisions will require involvement of the groundwater workgroup during key phases of the evaluation, and the actions will be implemented through the IMP process. The Quarterly and Annual RFCA Groundwater Reports will track the long term results of the monitoring activities and recommend changes if necessary.

3.2 Groundwater Program Objectives

The objectives of the Site groundwater program are to 1) protect surface water quality, 2) ensure compliance with regulations, 3) minimize the chances of further degradation of the Upper Hydrostratigraphic Unit (UHSU), and 4) support the design and selection of remedial measures and assess the effect of any future remedial actions. Development of the IMP and subsequent updates are the responsibility of the Environmental Restoration Department of Rocky Mountain Remediation Services, L.L.C. (RMRS/ER) under the direction the Kaiser-Hill Company, L.L.C. (Kaiser-Hill) and the DOE, RFFO. RMRS/ER directs and implements the Groundwater Monitoring Program. The Site management structure is shown in Figure 3-2.

3.3 Monitoring Objectives

The Site Groundwater Monitoring Program will be integrated with ongoing activities designed to protect surface water from contamination by groundwater. The Groundwater Monitoring Program will do the following:

- Identify groundwater containing contaminants;
- Identify and control contaminant sources;
- Identify contaminant pathways;
- Monitor contaminant concentrations;
- Monitor remediation and decontamination and decommissioning (D&D) actions;
- Protect groundwater from new sources of contamination; and
- Evaluate the effects of groundwater contaminants on surface water.

3.3.1 Identification of Potential Contaminants

A chemical inventory system has operated since 1986. The current real-time chemical tracking system, which identifies chemicals used on Site that are potential contaminants, has been in operation since 1990. It fulfills RCRA requirements to track the disposition of hazardous chemicals. The Waste Programs Organization at the Site manages this tracking system.

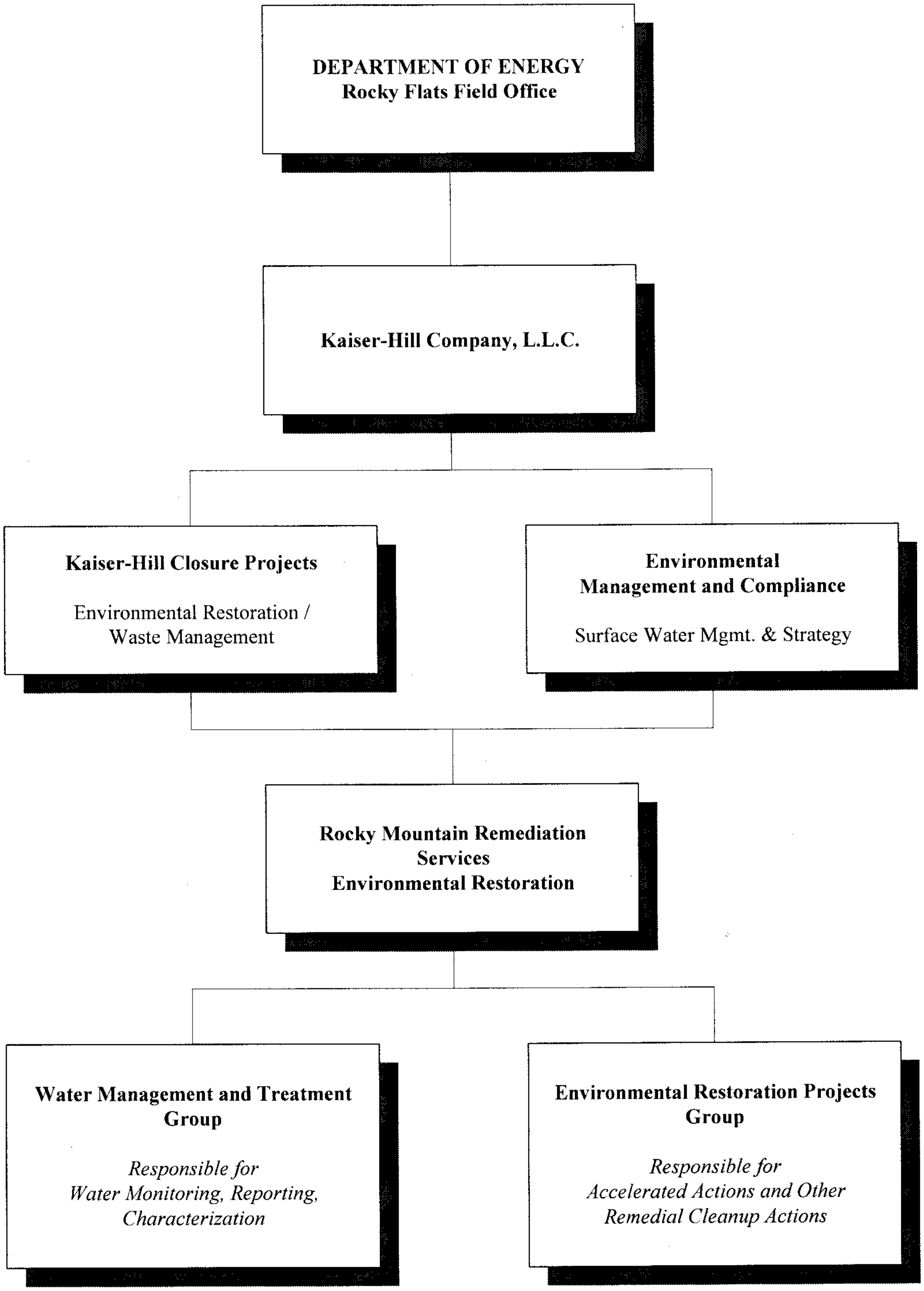
In addition, the HRR (DOE, 1992b) was compiled to originally document spills and other releases of potentially hazardous chemicals at the Site. This report is updated annually and is maintained by the RMRS/ER Department.

3.3.2 Identification and Control of Contaminant Sources

Site area sources contaminated with hazardous substances are identified as Individual Hazardous Substance Sites (IHSSs) and have been characterized under the Remedial Investigation/Feasibility Study (RI/FS) process. The IHSS ER Ranking Project is required under RFCA to determine the relative risk associated with contaminant sources and assign a priority for remediation. Those IHSSs that have contributed to groundwater contamination have been identified and put into the priority list for remediation. The HRR will document any new sources of contamination and will assign an IHSS number to a significant release.

137

Figure 3-2
Organizational Responsibilities for Groundwater



138

3.3.2.1 Current Contaminated Areas

The remedial investigations at Operable Units (OUs) (a grouping of IHSSs) have provided adequate data for determining potential contamination sources for much of the Site. The Industrial Area OU has not been characterized as thoroughly as other OUs, but initial soil screening results helped to characterize sources in this area.

Table A-1 lists the IHSSs at the Site. Information about the effect of contaminated areas on groundwater is described in Appendix D to this section. Table D-1 lists the potential contaminants of concern (PCOC) in groundwater and in other media, based on risk assessment criteria in the OUs that have been characterized. The remedial investigations at OUs, combined with Site-wide groundwater characterization activities, have identified a number of groundwater contaminant plumes that emanate from contaminant sources. These plumes are described in Appendix D to this section. The dominant category of hazardous contaminants in groundwater are VOCs. Where feasible, general plume maps have been developed to show the extent of contamination in UHSU groundwater. Plate 3 shows the composite plumes of VOCs and the Solar Ponds nitrate plume. Analyte suites have been developed for wells that reflect the major contaminants of concern.

In areas where groundwater will be monitored during D&D activities, building-specific potential PCOCs will be developed. The RFCA ALF requires performance monitoring of remedial actions. Analyte suites will be developed for these wells based on knowledge of the contaminants of concern at the remediation site (DOE, 1996). However, a full sample suite will initially be collected for these wells as a check on known PCOCs.

Remediation activities protect groundwater by minimizing further migration of potential contaminants and by cleaning contaminated areas. Data are gathered to identify the extent of contamination and the rate of contaminant migration, and to develop a plan for appropriate remedial actions. Data generated by the Groundwater Monitoring Program support the goals of identifying and remediating existing contaminated areas, detecting new contamination caused by D&D or other activities, and preventing contamination of surface water.

3.3.2.2 Hazardous Waste Management Areas

Hazardous or mixed waste management areas at the Site are generally operated in compliance with the RCRA requirements applicable to each area. These are further described in the *Spill Prevention, Control, and Countermeasures/Best Management Practices (SPCC/BMP) Plan* (EG&G, 1992) and the RCRA Part B Permit. The RCRA waste management functions at the Site are the responsibility of Waste Programs.

139

3.3.2.3 Storage Tanks

The more than 2,000 storage tanks at the Site include underground storage tanks, production or process waste tanks, chemical feed tanks, and fuel oil tanks. Most production and process waste tanks are considered to have secondary containment because they are located inside buildings or have systems that contain spills. Some of the chemical feed and fuel oil tanks also have spill containment systems; these tanks are considered low risk for spills to the ground and thus unlikely to contaminate groundwater.

Further characterization and spill controls for non-waste storage tanks will be achieved with the implementation of the Tank Management Plan, which was developed as a result of the 1989 chromic acid incident (EG&G, 1990). The tank management project employs formal design, testing, and inspection standards to evaluate tanks and prevent environmental contamination. This Tank Management Plan complies with Title 40 of the *Code of Federal Regulations* (CFR) Parts 280, 281, and 282, where applicable. The Waste Programs Organization at the Site maintains and controls the tanks.

3.3.2.4 Process Waste System

The process waste system comprises process waste lines and valve vaults. Groundwater is protected from these systems by 1) inspection of single-contained lines, which are only in accessible locations, 2) development of secondary-containment systems for lines that are not as accessible, and 3) continuous monitoring of leak detectors.

3.3.2.5 Building Drains

The Drain Identification Study (DIS) at OU8 (DOE, 1994b) identifies all those buildings with floor and footing drains located in areas containing potentially hazardous substances, and characterizes whether they lead to sanitary or process waste treatment facilities. Floor and footing drains are considered potential contaminant pathways since a large spill could enter the drains and be transported to the surface-water control system. Should this happen, the spill would be retained, sampled, treated, and released in compliance with permit conditions. Final completion of all DIS tasks, including corrective actions, was completed in August 1996. The *Technical Memorandum No. 1 Data Compilation, Rocky Flats Plant, 700 area (OU8)* (DOE, 1994b) compiles locations and specifications on foundation drains, storm sewers, and sanitary sewers. This information may help define how the drain systems could affect groundwater and surface water flow and migration.

3.3.2.6 Other Potential Contamination Sources

Underground buildings, building operations, and building sumps are also potential sources of contamination. The effect of these sources on groundwater will be further investigated as part of the RMRS/ER program and integrated with D&D activities.

3.3.3 Identification of Potential Contaminant Pathways

To assess the direction and magnitude of contaminant movement, both natural and manmade groundwater migration pathways must be known. The Site groundwater flow regime is determined from water level measurements at monitoring wells. This information can be used to help estimate recharge and discharge rates, and it can be incorporated into water table maps and groundwater flow models that help predict the path along which contaminants migrate.

3.3.4 Identification of Contaminant Concentrations

Routine chemical analysis of groundwater identifies both the contaminants present and the concentration of contaminants with respect to Site action levels or standards. Background concentrations have been established for most inorganic compounds present in groundwater at the Site. These Site-specific background levels are used to help determine concentrations that are anomalous with respect to natural levels. Increases in contaminant concentrations with time may indicate that contaminants are migrating from sources that could affect surface water.

3.3.5 Monitoring of Remedial Actions

The majority of the Site remedial investigation and characterization activities have been completed. Based on these remedial investigations, some interim remedial actions have already been completed, such as the groundwater treatment systems that have been built at the former OU4 and the former OU1. Performance monitoring of groundwater is required for those remedial activities where groundwater has been impacted.

The Interceptor Trench System (ITS) was installed on the hillside north of the Solar Ponds to decrease groundwater migration towards Walnut Creek and to collect groundwater contaminated with high concentrations of radionuclides and nitrate. The water collected in the ITS is pumped to the Building 374 Treatment Plant for processing. Groundwater is not currently monitored immediately downgradient of the ITS, but the Walnut Creek drainage below the ITS is monitored to detect contaminants that are not collected by the system.

The OU1 French Drain System was installed on the 881 Hillside to collect groundwater migrating towards Woman Creek. In addition, groundwater is intercepted in a collection well located near the French Drain and transferred to the Building 891 Treatment Plant nearby. Water that enters the drain is also pumped to the Building 891 Treatment Plant for processing. Groundwater is monitored downgradient of the French Drain system to detect any leakage of potentially contaminated groundwater toward Woman Creek.

Additional remedial activities are planned, as accelerated actions, to excavate and remove hazardous waste sources and to set up additional treatment systems for groundwater. The ALF addendum to RFCA requires performance monitoring of groundwater affected by remedial cleanup activities. It is anticipated that performance monitoring decisions will be made on a case-by-case basis but will follow a general decision rule that is described in a later section.

141

3.3.6 Protection from New Contaminant Sources

Future plans for the Site involve decommissioning of Site production systems, building demolition, and excavation and removal or capping of source areas. The IM/IRA for the Industrial Area (DOE, 1994a) proposed a framework for monitoring the effects of building D&D on air, surface water, and groundwater quality. Groundwater will be monitored before, during, and immediately after any operation that could potentially degrade groundwater quality. This monitoring will determine the Site-specific ambient groundwater conditions and detect any release of contaminants to groundwater. Construction activities are also assessed to ensure that groundwater quality is not compromised. Groundwater protection will be considered in future D&D work plans to supplement existing programs for water collected and contained in the building footing drains, basements, valve vaults, and sumps in the Industrial Area . The goal is to monitor the Industrial Area perimeter and promptly detect any contaminant releases, primarily during D&D activities.

Additional sources of Site groundwater contamination may be identified by evaluating data from the groundwater monitoring network at the Site. Evaluation of these data may identify new areas with elevated contaminant concentrations.

3.3.7 Evaluation of Groundwater Contaminant Impacts on Surface Water

In the event that monitoring shows that a groundwater contaminant plume may reach and impact surface water, evaluations will be made to assess this impact. An activity plan will be prepared to identify the specific DQOs necessary for the proper collection and interpretation of information, such that an impact assessment can be made. Once a determination of impact to surface water has been made, a remedial action priority will be assigned.

3.4 Groundwater Data Quality Objectives

DQOs are qualitative and quantitative statements that specify the type, quality, and quantity of the data required to support decision making. At the programmatic level, DQOs are established to ensure that a project has been logically defined and planned, and that project scope will support the eventual decisions required. At the operational level, quality control objectives (QCOs) are established to ensure that data generated by the project will withstand scientific and legal scrutiny, and that the data will be gathered or developed using procedures appropriate for the intended use of the data.

3.4.1 Programmatic Data Quality Objectives

The DQO process was applied to the Site groundwater program at both a programmatic and decision-specific level. At the programmatic level, the DQO process was used to qualitatively evaluate the overall need for, and purpose of, groundwater monitoring. This effort established that groundwater data are needed to comply with applicable regulations, agreements, permits,

142

and to prevent unacceptable risks to public health and the environment through impacts to surface waters of the state. The information required to satisfy these requirements results from regular sampling of wells and surface locations selected to meet the above criteria. These data will be used to detect and document concentrations above limits established by regulations, agreements, permits, or risk-based analysis; to support planning, implementation, and assessment of removals, remedial actions, and D&D projects; to support modeling and evaluations; and to meet commitments to issue periodic monitoring reports to regulators. Sampling locations and frequency have been negotiated with regulators; locations were chosen to detect migration of known contaminant plumes along pathways and across boundaries. Analytical results need to be of high quality, owing to the many uses of the data — modeling, risk assessment, performance assessment, and compliance. These programmatic statements establish the general need for a groundwater monitoring program and outline program elements that need to be included.

3.4.2 Data Quality Objectives for Program Elements

The second DQO effort developed individual monitoring program decision elements. DQOs were approached on a medium-specific basis, although the goal was to integrate monitoring requirements for all media (e.g., surface water, ecology, air). Groundwater monitoring DQOs were developed for each component of the program and problem statements were established. These problem statements were then refined into a decision statement that specified corrective actions for that problem. Then data were identified and methods of analysis outlined to support the decision. Boundaries and scope are defined to clarify the spatial and temporal focus of the required monitoring information and exclude nonessential aspects of the problem. A decision rule was specified to document how data will be summarized to draw a conclusion upon which a decision will be based.

The groundwater monitoring network was defined with the Site-wide components described below.

- Plume Definition Wells: Wells that are within known contaminant plumes and are above Tier II Action Levels, but are below the Tier I Action Levels established in the ALF. These wells will be monitored to determine whether concentrations of contaminants are increasing, and, if a Tier I Action Level is exceeded, will be reported as a Tier I exceedance and be prioritized for remedial action.

- Plume Extent Wells: Wells at the edges of known groundwater contaminant plumes along pathways to surface water. A subset of these wells is listed in the ALF as Tier II Wells. The wells are monitored for increases in concentrations that would exceed Tier II Action Levels stated in the ALF, and they indicate movement that may result in contamination of surface water.

- Drainage Wells: Monitoring wells located in stream drainages downgradient of contaminant plumes. If contamination reaches these wells, and action levels are exceeded, they fall under the same requirements as plume extent wells.

- Boundary Monitoring Wells: Wells used to monitor the quality of groundwater leaving the eastern Site boundary.

In addition to this general groundwater monitoring scheme, specific requirements support regulatory directives. The following special categories are included as groundwater program elements:

- D&D Monitoring Wells: Wells used to monitor releases to groundwater from D&D activities on specific buildings. This requirement is specified in the IM/IRA for the Industrial Area (DOE, 1994a).

- Performance Monitoring Wells: Wells used to monitor the effect of a remedial treatment or source removal action. Performance monitoring of source remediation is specifically required in the RFCA ALF for groundwater. The French drain performance monitoring wells are included in this category and are specified in the French Drain IM/IRA plan (DOE, 1992a).

- RCRA Compliance Wells: Wells used in upgradient and downgradient monitoring of RCRA interim status units. This requirement is specified under 6 *Code of Colorado Regulations* (CCR) 1007-3. Wells monitored at the new landfill would be specified under 6 CCR 1007-2. Future retrievable storage facilities would also fall under the RCRA monitoring category.

On-Site groundwater has a surface water protection use classification and must be managed to be protective of surface water quality. The ALF lists specific analytes and the associated groundwater action levels. All DQO decisions will reflect the RFCA requirement to support the surface water protection classification. Each component of the groundwater program can be considered a decision element, and decision statements have been created for each component.

3.4.2.1 Plume Definition Wells

Problem Statement:

Are contaminants within groundwater plumes increasing in concentration with time or reaching Tier I Action Levels with the potential to impact surface water?

Problem Scope:

Plume definition wells lie within the currently known groundwater contaminant plumes and are located appropriately to monitor groundwater pathways that could affect surface water. Plume definition wells are designated based on knowledge of existing groundwater contaminant plumes and particle flow models that simulate groundwater pathways. It is possible that some plume definition wells have historically exceeded

144

Tier I Action Levels. For these wells, only new exceedances of Tier I Action Levels involving compounds that have concentrations greater than historic levels will cause the well to be reprioritized for remedial action.

Inputs:

- RFCA Tier I Action Levels;
- Background mean + 2 standard deviations;
- Historic baseline for contaminants;
- Selected analyte suites based on historic data (see Appendix E to this section);
- Historic data trends for contaminants;
- Field parameters; and
- Water levels.

Boundaries:

Spatial: Wells are located in areas known to be contaminated above the Tier II Action Level. Decisions will be made on an individual well basis.

Temporal: Data will be reviewed quarterly and decisions will be made annually.

Decision Statement:

IF Measured concentrations in well exceed Tier I Action Levels and background mean +2 standard deviations—

THEN Report as a Tier I exceedance and review historic data for well to determine if it has been prioritized for remediation/evaluation based on potential impact to surface water.

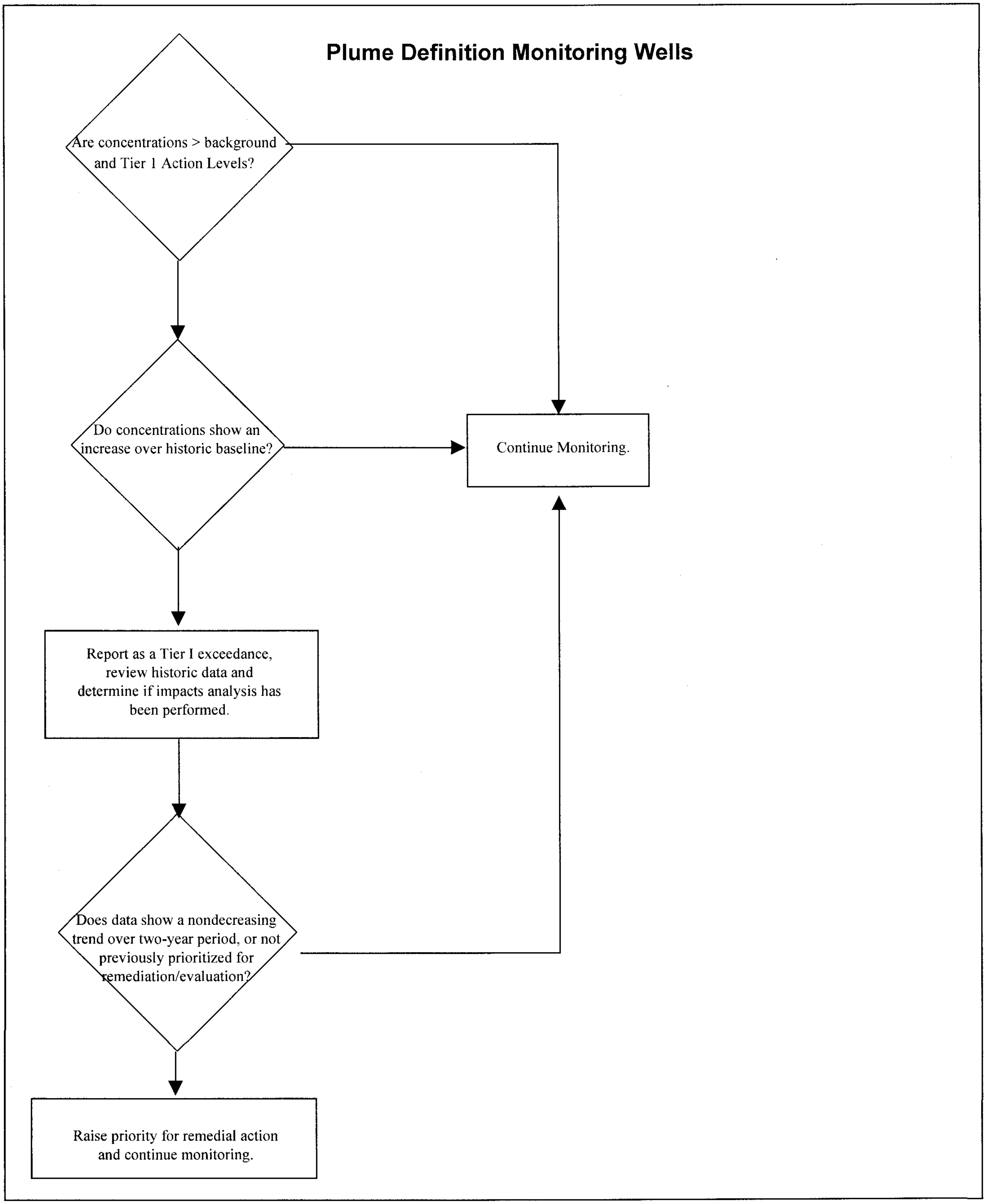
IF Data show a nondecreasing or increasing trend over a two-year period, or well has not been previously prioritized for remediation—

THEN Update priority for remediation/evaluation,

ELSE Continue monitoring.

145

Logic:


Plume Definition Monitoring Wells
Are concentrations > background and Tier 1 Action Levels?
Do concentrations show an increase over historic baseline?
Continue Monitoring.
Report as a Tier I exceedance, review historic data and determine if impacts analysis has been performed.
Does data show a nondecreasing trend over two-year period, or not previously prioritized for remediation/evaluation?
Raise priority for remedial action and continue monitoring.

146

3.4.2.2 Plume Extent Monitoring Wells

Problem Statement:

Have concentrations in wells exceeded Tier II Action Levels?

Problem Scope:

Plume extent monitoring is conducted to detect potential impact to surface water from known or suspected groundwater contamination plumes. Some of these wells are specifically listed as Tier II wells in the RFCA ALF for groundwater. If groundwater exceeds Tier II Action Levels, an evaluation is required to determine if remedial or management action is necessary to prevent surface water from exceeding standards. It is possible that some plume extent wells have historically exceeded Tier II Action Levels. For these wells, only new compounds with exceedances of Tier II Action Levels or involving compounds that have concentrations greater than historic levels will be sampled on a monthly basis as required by RFCA.

Inputs:

- RFCA Tier II Action Levels;
- Background mean + 2 standard deviations;
- Historic baseline for contaminants;
- Selected analyte suites based on historic data (see Appendix E to this section);
- Historic data trends for contaminants;
- Field parameters; and
- Water levels.

Boundaries:

Spatial: Decisions will be made on an individual well basis.

Temporal: Data will be reviewed quarterly and decisions will be made on an annual basis.

Decision Statement:

IF Sample results show detections in a well that exceed Tier II action levels and background mean + 2 standard deviations—

THEN Report as a Tier II exceedance, review historic data for well, and determine if evaluation of impact to surface water has been done.

IF Historic data confirm the exceedance and impact evaluation has not been done—

THEN Notify appropriate parties and evaluate impacts to surface water.

IF Historic exceedances have not been documented or concentrations for a known contaminant are greater than the mean + 2 standard deviations with respect to the historic data set for that well—

THEN Initiate monthly sampling for three months.

IF Monthly sampling confirms the exceedance—

THEN Notify appropriate parties and determine whether a remedial or management action is necessary,

ELSE Continue monitoring.

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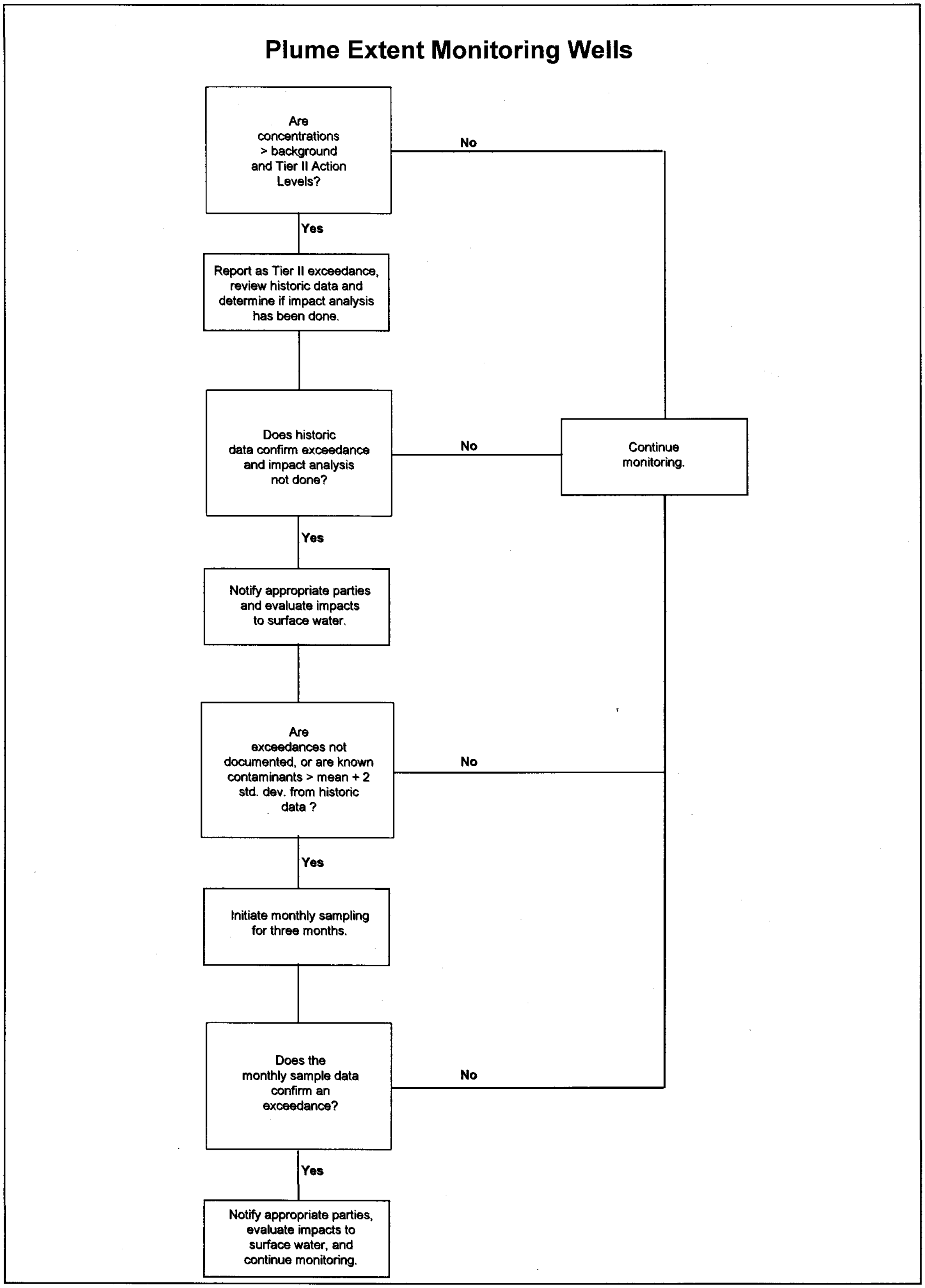

Plume Extent Monitoring Wells
Are concentrations > background and Tier II Action Levels?
No
Yes
Report as Tier II exceedance, review historic data and determine if impact analysis has been done.
Does historic data confirm exceedance and impact analysis not done?
No
Continue monitoring.
Yes
Notify appropriate parties and evaluate impacts to surface water.
Are exceedances not documented, or are known contaminants > mean + 2 std. dev. from historic data ?
No
Yes
Initiate monthly sampling for three months.
Does the monthly sample data confirm an exceedance?
No
Yes
Notify appropriate parties, evaluate impacts to surface water, and continue monitoring.

3.4.2.3 Drainage Monitoring Wells

Problem Statement:

Do contaminants that have reached surface water in groundwater exceed action levels, and are they migrating downgradient in valley fill alluvium?

Problem Scope:

In some areas, groundwater contamination from multiple sources has migrated to surface water drainages. Drainage wells monitor groundwater in valley fill alluvium downstream of areas where contaminant plumes may have reached surface water stream drainages. Any contaminants detected in stream drainages are assumed to have affected surface water and to have the potential to migrate off Site. It is possible that some drainage wells have historically exceeded Tier II Action Levels. For these wells, only new compounds with exceedances of Tier II Action Levels or involving compounds that have concentrations greater than historic levels will be sampled on a monthly basis as required by RFCA.

Inputs:

- RFCA Tier II Action Levels;
- Background mean + 2 standard deviations;
- Historic baseline for contaminants;
- Selected analyte suites based on historic data (see Appendix E to this section);
- Historic data trends for contaminants;
- Field parameters; and
- Water levels.

Boundaries:

Spatial: Decisions will be made on an individual well basis.

Temporal: Data will be reviewed quarterly and decisions will be made annually.

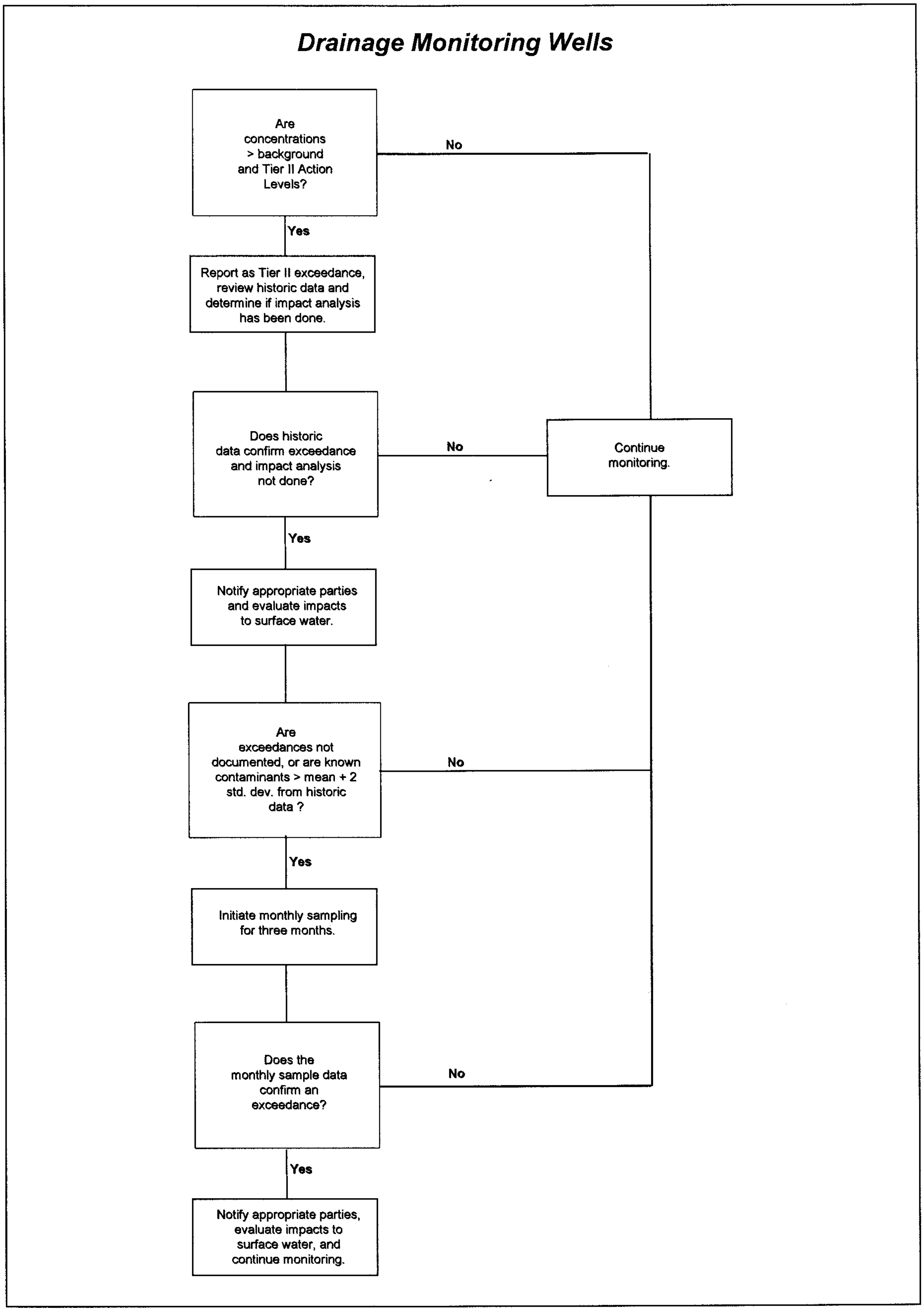
150

Decision Statement:

IF	Sample results show detections in a well that exceed Tier II Action Levels and background mean + 2 standard deviations—
THEN	Report as a Tier II exceedance, review historic data for well, and determine if evaluation of impact to surface water has been done.
IF	Historic data confirm the exceedance and impact evaluation has not been done—
THEN	Notify appropriate parties and evaluate impacts to surface water.
IF	Historic exceedances have not been documented or concentrations for a known contaminant are greater than the mean + 2 standard deviations with respect to the historic data set for that well—
THEN	Initiate monthly sampling for three months.
IF	Monthly sampling confirms the exceedance—
THEN	Notify appropriate parties and evaluate impacts to surface water,
ELSE	Continue monitoring.

151

Logic:


Drainage Monitoring Wells
Are concentrations > background and Tier II Action Levels?
No
Yes
Report as Tier II exceedance, review historic data and determine if impact analysis has been done.
Does historic data confirm exceedance and impact analysis not done?
No
Continue monitoring.
Yes
Notify appropriate parties and evaluate impacts to surface water.
Are exceedances not documented, or are known contaminants > mean + 2 std. dev. from historic data ?
No
Yes
Initiate monthly sampling for three months.
Does the monthly sample data confirm an exceedance?
No
Yes
Notify appropriate parties, evaluate impacts to surface water, and continue monitoring.

3.4.2.4 Boundary Monitoring Wells

Problem Statement:

Do contaminants in groundwater exceed groundwater action levels, and do they migrate off Site?

Problem Scope:

Boundary wells monitor groundwater at the downstream boundary of the Site. Any contaminants detected in boundary wells that are above background and also above action levels are assumed to have impacted surface water and to have migrated off Site. Historically, the Site has monitored wells at the Indiana Street boundary to provide the surrounding cities with added certainty that there are no contaminants in alluvial groundwater leaving the Site. It is possible that some boundary wells historically exceeded Tier II Action Levels. For these wells, only new compounds that exceed Tier II Action Levels or that have concentrations greater than historic levels will be sampled on a monthly basis as required by RFCA.

Inputs:

- RFCA Tier II Action Levels;
- Background mean + 2 standard deviations;
- Historic baseline for contaminants;
- Selected analyte suites based on historic data (see Appendix E to this section);
- Historic data trends for contaminants;
- Field parameters; and
- Water levels.

Boundaries:

Spatial: Alluvial groundwater in the drainages at the Indiana Street boundary. Decisions will be made on an individual well basis.

Temporal: Data will be reviewed quarterly and decisions will be made annually.

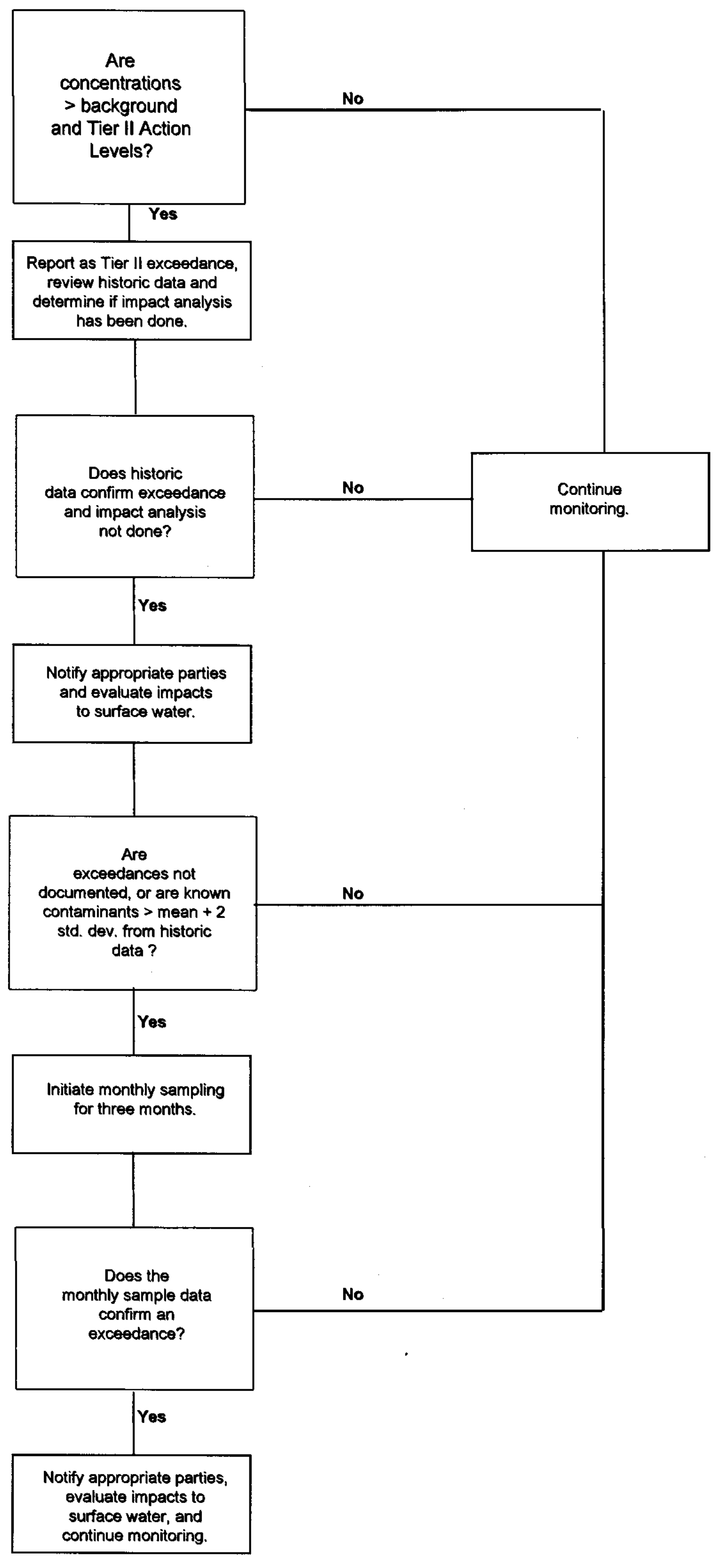
153

Decision Statement:

IF	Sample results show detections in a well that exceed Tier II Action Levels and background mean + 2 standard deviations—
THEN	Report as a Tier II exceedance, review historic data for well, and determine if evaluation of impact to surface water has been done.
IF	Historic data confirms the exceedance and impact evaluation has not been done—
THEN	Notify appropriate parties and evaluate impacts to surface water.
IF	Historic exceedances have not been documented or concentrations for a known contaminant are greater than the background mean + 2 standard deviations with respect to the historic data set for that well—
THEN	Initiate monthly sampling for three months.
IF	Monthly sampling confirms the exceedance—
THEN	Notify appropriate parties and evaluate impacts to surface water,
ELSE	Continue monitoring.

Logic:

Boundary Monitoring Wells



155

3.4.2.5 Building–Specific D&D Monitoring Wells

Problem Statement:

Have building-specific D&D activities degraded groundwater in a way that can impact surface water?

Problem Scope:

Building-specific D&D activities involve three major steps: deactivation of building processes, demolition of building structures, and remediation of building foundations and surroundings. The IM/IRA for the Industrial Area (U.S. DOE, 1994) outlines monitoring activities to ensure that building-specific D&D actions do not inadvertently degrade surface water through a groundwater transport pathway. The proposed monitoring will provide the data needed to determine if precautions or actions taken during D&D adequately prevent migration of contaminants to groundwater. D&D monitoring will begin at least one year before building demolition and continue for five years after demolition, sampled on a semiannual frequency.

Inputs:

- Building-specific PCOCs (to be determined);
- Baseline mean $\pm$ 2 standard deviations;
- Field parameters (to be determined); and
- Water levels.

Boundaries:

Spatial: Decisions will be made on an individual well basis.

Temporal: Data will be reviewed quarterly and decisions will be made annually.

Decision Statement:

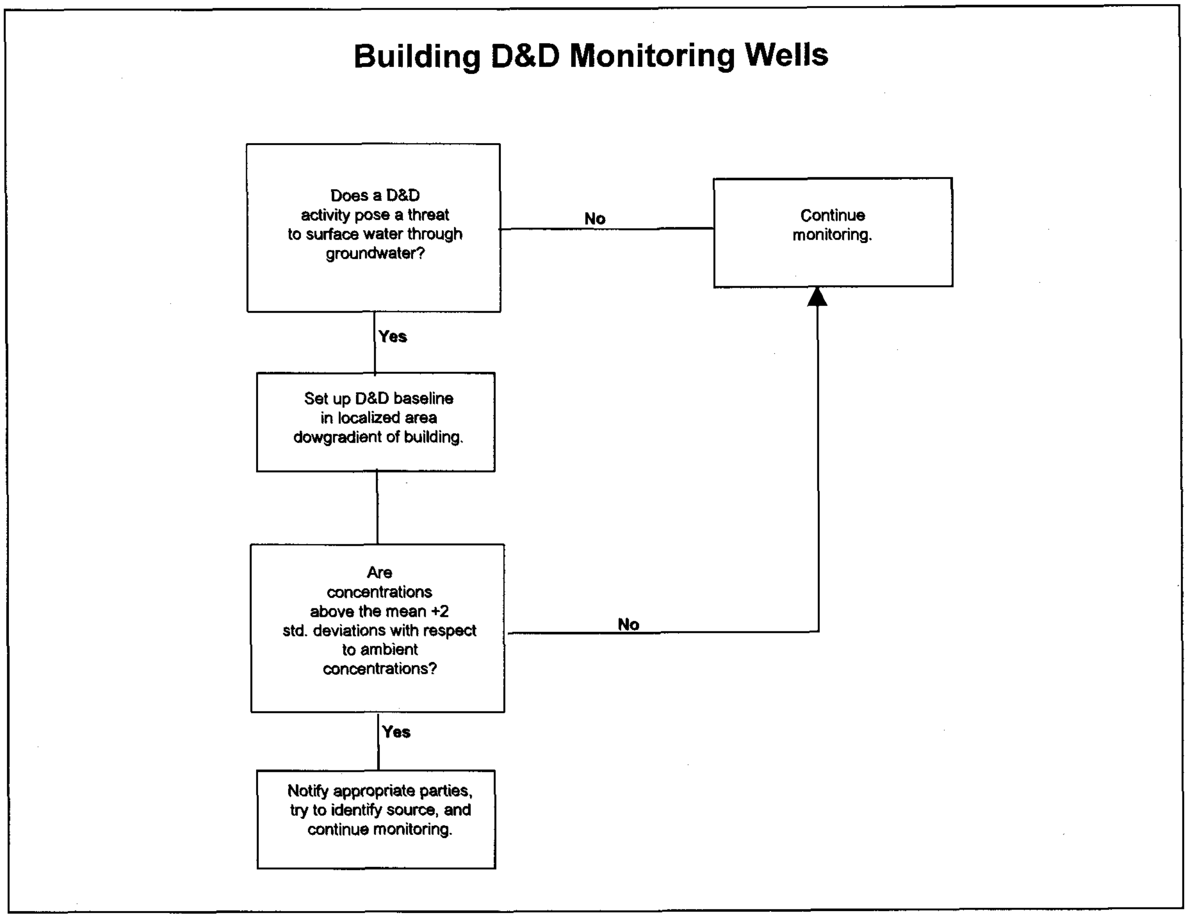
IF Existing information from a proposed D&D activity indicates a potential threat to surface water through a groundwater pathway—

THEN Establish a pre-D&D baseline using wells located upgradient and downgradient of buildings.

156

IF	Exceedances are detected greater than the mean + 2 standard deviations above baseline—
THEN	Inform appropriate parties and evaluate the problem,
ELSE	Continue monitoring.

Logic:



3.4.2.6 Performance Monitoring Wells

Problem Statement

Have remedial actions improved or further impacted groundwater?

Problem Scope:

Performance monitoring assesses the effectiveness of remedial activities such as contaminant source removals or treatment systems that are installed to clean groundwater plumes. In general, source removals are monitored by comparing current values to values

157

that existed before the remedial action. RFCA requires performance monitoring of all groundwater and appropriate soil remediation actions. Specific activities will be determined on a case-by-case basis and will be established in decision documents for those projects where it is required. Details will be determined by the groundwater work group in conjunction with project managers and incorporated into the IMP.

Inputs:

- Source-specific PCOCs (to be determined);
- Field parameters (to be determined); and
- Water levels.

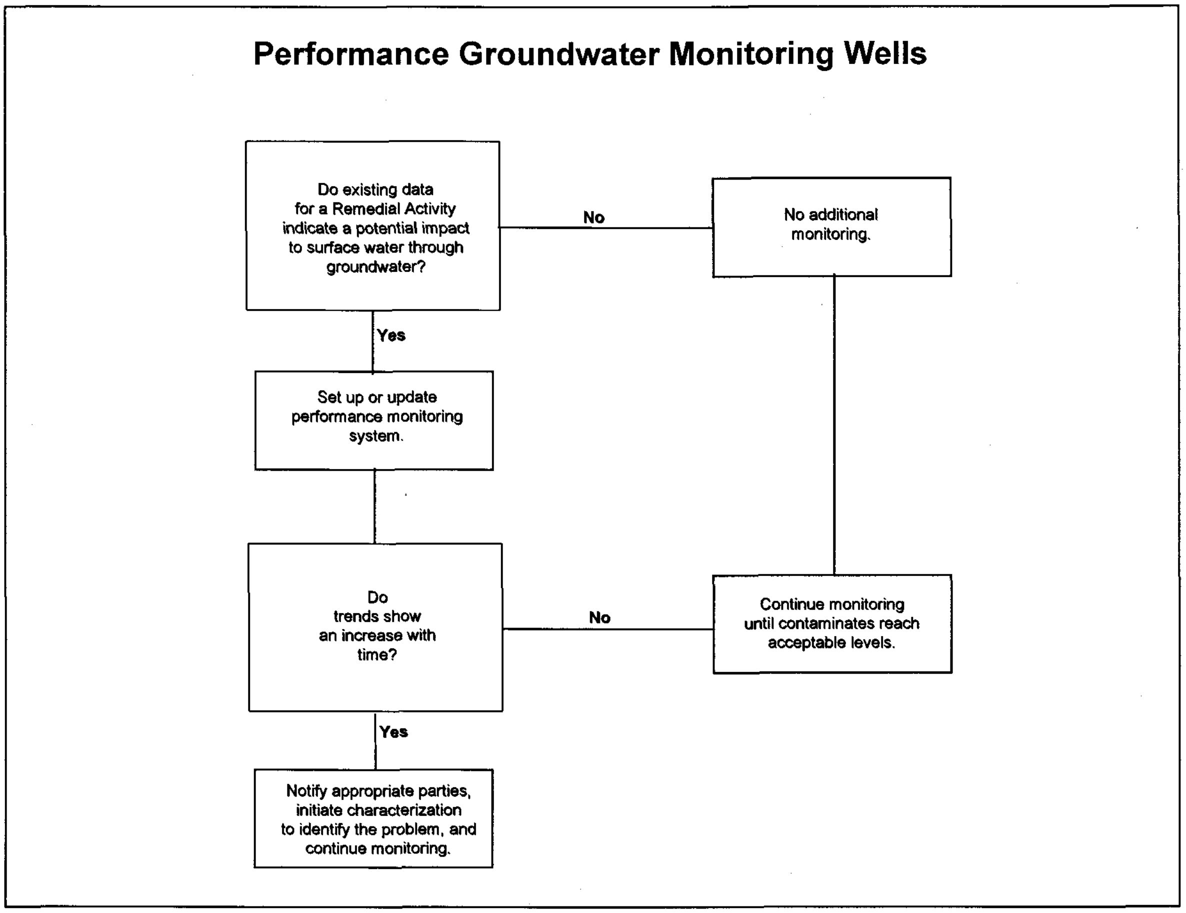
Boundaries:

Spatial:	Decisions will be made on a well-by-well basis. Wells will be placed downgradient from sources undergoing remediation.
Temporal:	Data will be reviewed quarterly and decisions will be made annually.

Decision Statement:

IF	Existing data or information from a remedial activity suggest potential impact through groundwater pathways to surface water—
THEN	Establish monitoring points and initiate sample collection.
IF	Monitoring detects that the concentration of contaminants increases with time—
THEN	Inform appropriate parties and initiate evaluation to assess the extent of the problem,
ELSE	Continue monitoring until contaminant levels are reduced to acceptable levels.

Logic:



3.4.2.7 RCRA Monitoring Wells

Problem Statement:

Have concentrations of contaminants in downgradient monitoring wells exceeded the mean concentrations in upgradient monitoring wells at RCRA units?

Problem Scope:

RCRA monitoring is conducted to detect potential excursions of contamination that are below the point of compliance established for RCRA units on Site. RCRA units are considered to be any units that are regulated under 6 CCR 1007-2 solid waste requirements, such as the Existing Landfill and the New Sanitary Landfill, and any future waste repositories. Attachment 10 of the RFCA will be followed in determining points of compliance and alternate concentration limits affecting these units.

159

Inputs:

- Unit-specific PCOCs;
- Field parameters; and
- Water levels.

Boundaries:

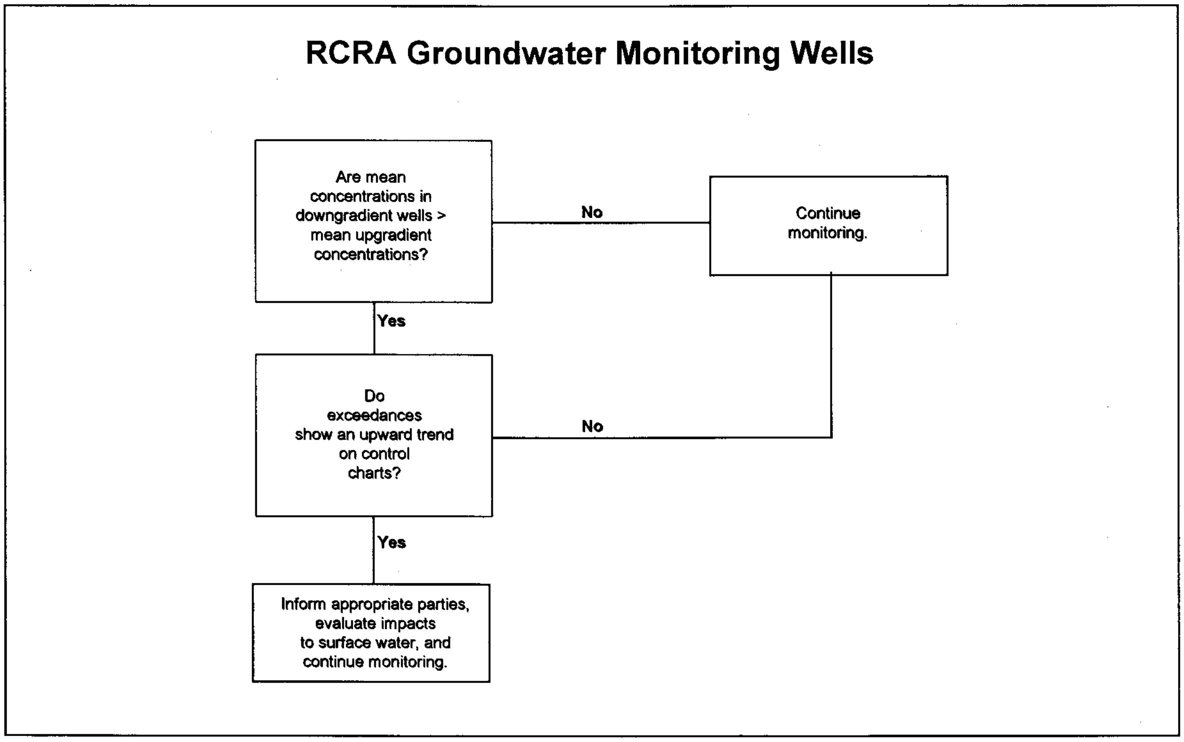
Spatial:	Decisions will be made based on pooled results of upgradient wells and on a well head basis in downgradient wells.
Temporal:	Data will be reviewed quarterly and decisions will be made annually.

Decision Statement:

IF	Mean concentrations in any downgradient well exceeds the mean concentration in upgradient wells
AND	Concentrations at any downgradient well increase with time—
THEN	Report to appropriate agencies and investigate possible causes,
ELSE	Continue monitoring.

1160

Logic:



3.4.2.8 Plume Degradation Monitoring Wells

Problem Statement:

Do natural processes acting on contaminants in groundwater affect the impact to surface water and therefore influence the priority and method of remediation?

Problem Scope:

The natural attenuation of contaminants in groundwater may be a significant factor influencing the nature and extent of contaminant migration. Plumes (and their potential sources) that have been evaluated under the IMP evaluation criteria and show evidence of natural attenuation may need additional characterization or monitoring to establish attenuation characteristics. Degradation monitoring would involve the placement and sampling of wells for use in decision making with respect to the methodology of source and plume remediation and will aid in assessing the priority for remediation.

\\6\

Inputs:

- Concentration and speciation of project specific contaminants in the source groundwater with respect to time;
- Concentration and speciation of project specific contaminants in downgradient groundwater with respect to time;
- Concentration and speciation of background water quality in upgradient groundwater with respect to time;
- Water levels to establish gradient and saturated thickness;
- Project-specific field parameters;
- Trend analysis; and
- Mass flow rate analysis.

Boundaries:

Spatial: Wells are located in areas thought to be contaminated from a specific source or upgradient to distinguish contamination from other sources.

Temporal: Data will be reviewed annually to determine if sufficient data have been collected to support remedial decision making. Upon collection of sufficient data an evaluation will be performed to establish inputs to the remedial conceptual model.

Decision Statement:

IF Data evaluation concludes that sufficient data have been collected to characterize the nature and extent of the contaminant plume

AND Evaluation concludes that natural processes have decreased potential contaminant impact to surface water—

THEN Determine course of action using decision analysis phase in IMP plume management template to reevaluate the priority and methodology for remediation and discontinue monitoring,

ELSE Reestablish sufficient data needs and re-scope monitoring activities

- General Strategy for Groundwater Plume Management and Remediation:

  — The existence of groundwater contaminant plumes at RFETS has been well documented. *The Groundwater Conceptual Plan* for the Rocky Flats Technology Site (Kaiser-Hill, 1996) presented a summary of the known information on individual groundwater plumes and possible remedial actions. This section will outline the general strategy and approach to plume management and decision making for groundwater plumes and show the integration of groundwater functions at the Site.

- The plume management strategy for RFETS will consist of the following components.

Detection:

The detection of groundwater contamination that could impact surface water at RFETS will be supported through the current water monitoring programs at RFETS as well as through historic data from past investigations and information on past contaminant spills. The surface and groundwater monitoring programs have been established to detect the migration of contaminants in water that could move off Site. The monitoring programs are dynamic and may be changed to accommodate new insights into contaminant migration. The maintenance of historic data in the Soil Water Database and the HRR (DOE, 1992b) help provide information on potential groundwater contamination problems.

The IMP gives DQOs that establish the methods of detection and the actions that will follow.

Evaluation:

Many of the DQO decisions for groundwater monitoring require that an evaluation be performed to assess impacts to surface water caused by potential groundwater contamination. In many cases, the evaluation is predicated on the confirmatory sampling that follows an exceedance of groundwater action levels. If follow up sampling confirms an exceedance, or if historic data have indicated an impact to surface water that has not been evaluated, an evaluation will be performed. In general, the evaluation phase will spawn a focused data quality objective which will determine the type of data that will need to be collected and the methodology for determining the nature and extent of contamination and its impact on surface water. The following are possible components of an evaluation of surface water impact:

- Definition of extent of contaminants through additional sampling of soil, groundwater, surface water or seeps;

- Definition of areal extent of the contaminant pathway through additional well/borehole installations;

- Establishment of discharge, flow velocity and direction for groundwater and/or surface water;

- Determination of concentration loadings and mass flux of contaminants to the stream; and

- Estimation of impacts due to seasonal variations, discharges, or removal of groundwater collection systems.

It is understood that each evaluation will have a unique DQO that will consider such factors as relative impact, priority, and risk to the public. This approach will ensure that the available budget will be allocated to areas with the highest potential for contamination. Once a significant impact to surface water has been established, the findings will be used to establish or update priorities for remediation. At that point, the scope will be promulgated as an accelerated action, Proposed Action Memorandum (PAM), or an IM/IRA. The ALF section in RFCA that deals with Tier II wells requires modeling of impacts to surface water through mass balancing and flux calculations, where action levels have been exceeded. It is assumed that these predictive components of the evaluation will be weighed against actual field data in setting the priority for remediation.

Remedial Decisions:

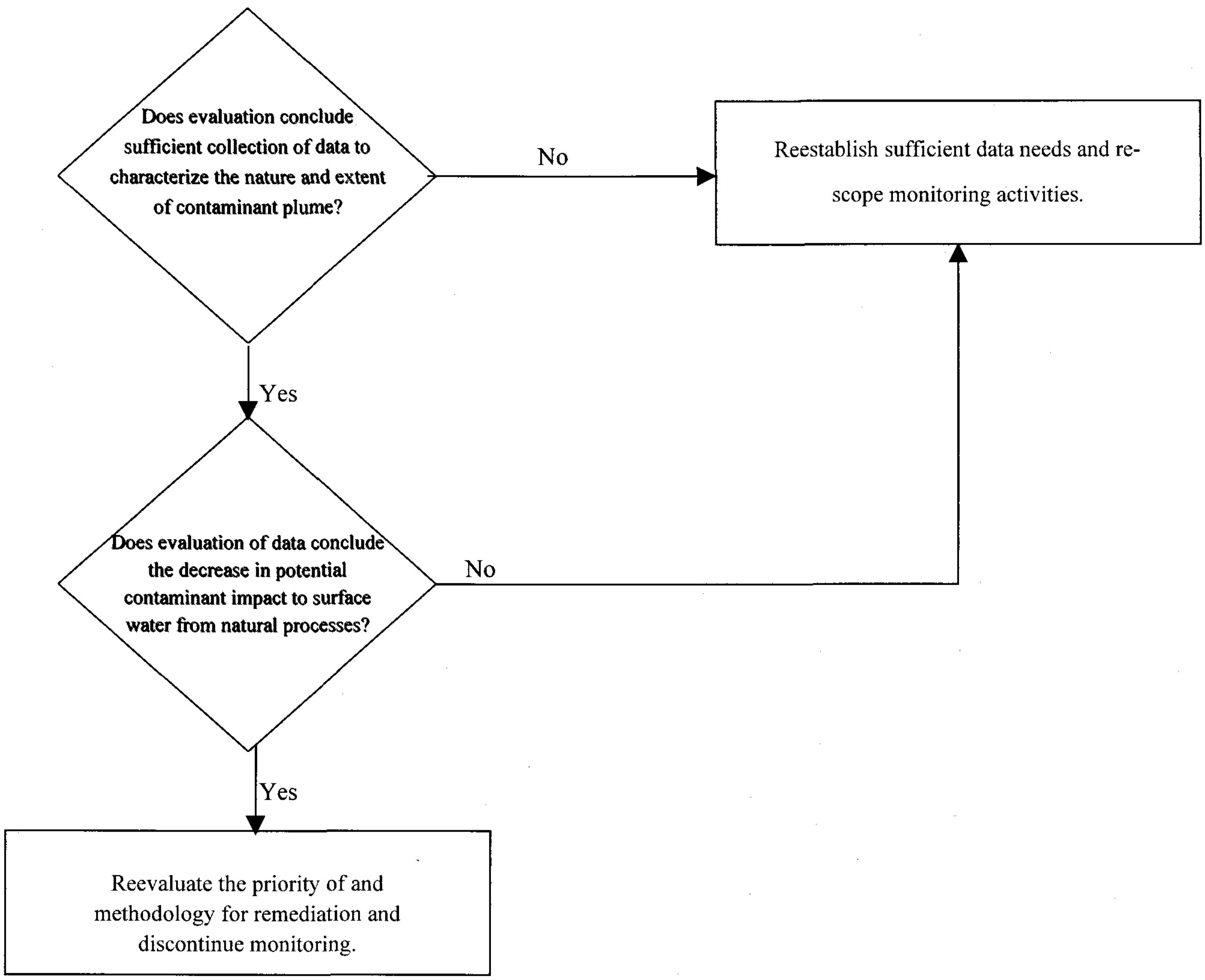
Once impact to surface water has been quantified, and the need for a remedial decision has been determined, the project scope will be promulgated as an accelerated action, PAM, or an IM/IRA. An alternatives analysis will be used to assess the remediation options. This analysis will consider such factors as risk reduction, remediation method, impact on the ecology, cost and performance. Once the remedial decisions have been reached, additional information may be needed to aid the design and construction of a remedial system. A DQO process will be employed to establish the data that need to be collected to aid in the construction of the remedial system. The remedial system may consist of a groundwater treatment system or source removal action. The decision alternatives analysis may propose that no remedial action be performed due to physical or technological impracticality, or adverse impact to the environment.

Remedial Decision Validation:

Additional groundwater monitoring may be required to validate the efficacy of a remedial action in reducing the risk of surface water impact. A DQO process will be employed to establish a performance monitoring system that will be maintained during and/or after remedial actions.

Logic:

PLUME DEGRADATION MONITORING WELLS



3.4.3 Data Quality Objectives for Monitoring Groundwater Flow

Groundwater quantity and the magnitude and direction of groundwater flow are necessary to assess the effects of Site operations on surface water quality and to design effective remedial actions (if such are needed). Compiling water level information from wells supports the following analyses:

145

- Assessment of the impact of contaminant plumes on surface water quality through the creation of potentiometric surfaces from which horizontal hydraulic gradient and flow path can be derived;

- Development of groundwater flow and transport models to assess the effect of groundwater contamination on surface water in the event that an action level is exceeded;
- Evaluation of impacts to downgradient habitat and endangered species caused by changes to groundwater quantity and associated fluvial systems as a result of Site remediation activities; and

- Estimation of direction and rate of plume migration and the volumes of contaminated groundwater for use in treatment feasibility scenarios.

3.4.3.1 Site-Wide Flow Monitoring

Problem Statement:

Do Site remediation activities that adversely affect the quantity, velocity, and direction of Site-wide groundwater flow also adversely affect downgradient habitats or surface water quality and quantity?

Problem Scope:

The three flow-monitoring components described below will provide groundwater flow information on a well-by-well basis. To fully evaluate the Site regional groundwater flow regime, monitoring must be spatially distributed to define a potentiometric surface so that maps of this surface can be produced. These potentiometric surface maps can then be used to determine groundwater volume and the velocity and direction of groundwater flow. Water level will be measured more frequently on the perimeter of the Industrial Area where flow information is critical. Wells in areas where groundwater flow is believed to be relatively slow will be monitored at least semiannually. This semiannual flow data will be collected during high recharge and low recharge periods of the year (generally spring and fall).

Inputs:

- Water level measurements;

- Frequency of action level sampling;

- Historic water level data; and

- Meteorological data.

1166

Boundaries:

Spatial: Decisions will be made on a regional basis.

Temporal: Data will be reviewed annually and decisions will be made on an annual basis.

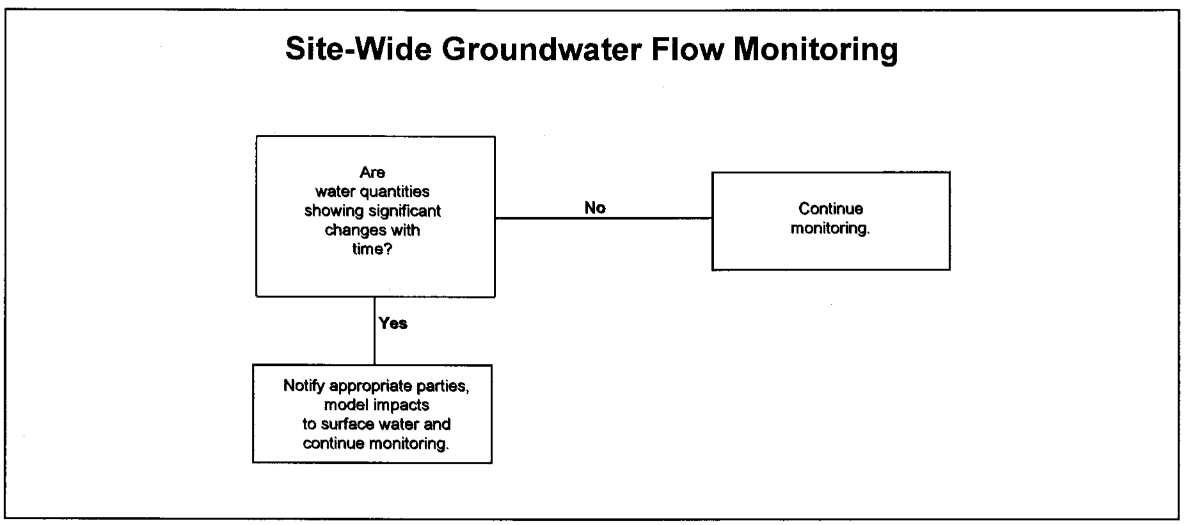
Decision Statement:

IF Groundwater elevations show significant changes in an area with time—

THEN Notify appropriate parties and evaluate impacts to surface water quality and quantity,

ELSE Continue taking measurements.

Logic:



The Site-wide groundwater flow monitoring program has three components. Each component provides information that supports the programmatic goals. The three components are as follows:

- Water Quality Flow Monitoring, which supports interpretation of water quality data in determining impacts to surface water.
- Industrial Area Flow Monitoring, which supports interpretation of changes to the groundwater flow regime leaving the Industrial Area to surface water resulting from remediation activities.

1167

- Background Flow Monitoring, which supports interpretation of changes in the contribution of groundwater to surface water resulting from Site remediation activities by monitoring natural and off-Site impacts.

3.4.3.2 Water Quality Flow Monitoring

Problem Statement:

Do changes in the water level and gradient of groundwater affect surface water quality and flow regime?

Problem Scope:

The alluvial water table responds to seasonal and event-related changes in recharge. Interpretations of the fate and transport of contaminants depend on knowledge of the hydraulic gradient and saturated thickness of the aquifer. The frequency of water level measurements should be sufficient to establish useable hydrographs so that the effects of water table fluctuations can be correlated with water quality data. Because water quality sampling frequency is increased when action levels are exceeded, water level frequency should be increased to match the sampling frequency.

Inputs:

Water level measurements.

Boundaries:

Spatial: Decisions will be made on a well head basis.

Temporal: Data will be reviewed quarterly and decisions will be made annually.

Decision Statement:

IF Action levels have been exceeded in the well—

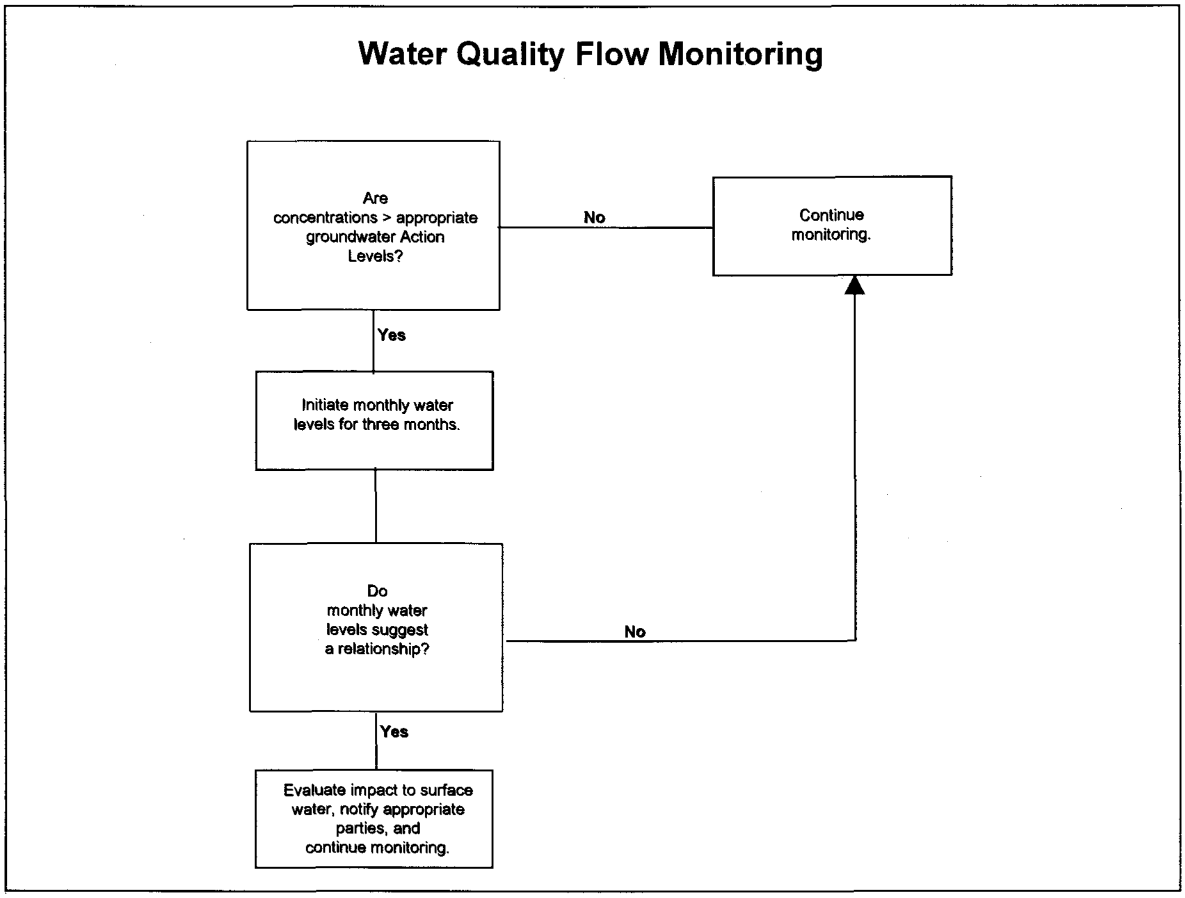
THEN Adjust water level frequency to mirror water quality sampling frequency

AND Evaluate impacts to determine whether a remedial or management action is necessary,

ELSE Continue water level measurement at regular frequency.

168

Logic:



3.4.3.3 Industrial Area Flow Monitoring

Problem Statement:

Do remedial activities affect the groundwater flow regime surrounding the Industrial Area, and what impact to these changes have on surface water quality and quantity?

Problem Scope:

The alluvial water table responds to both seasonal and event-related changes in recharge. To understand how remediation activities affect contaminant migration, surface water quality and quantity, and wetlands, the hydraulic gradient and saturated thickness of the aquifer must be known. Because source wells in the Industrial Area are now monitored less frequently, the level of resolution of groundwater flow is too low to predict the effect of Site activities on groundwater migration. The frequency of measurements should be increased to a level sufficient to track the effects of remedial actions in the Industrial Area.

1669

Inputs:

- Water level measurements; and
- Historic water level data.

Boundaries:

Spatial: Decisions will be made on a well head basis, but high resolution maps are also needed involving all Industrial Area wells that are monitored.

Temporal: Data will be reviewed quarterly and decisions will be made annually.

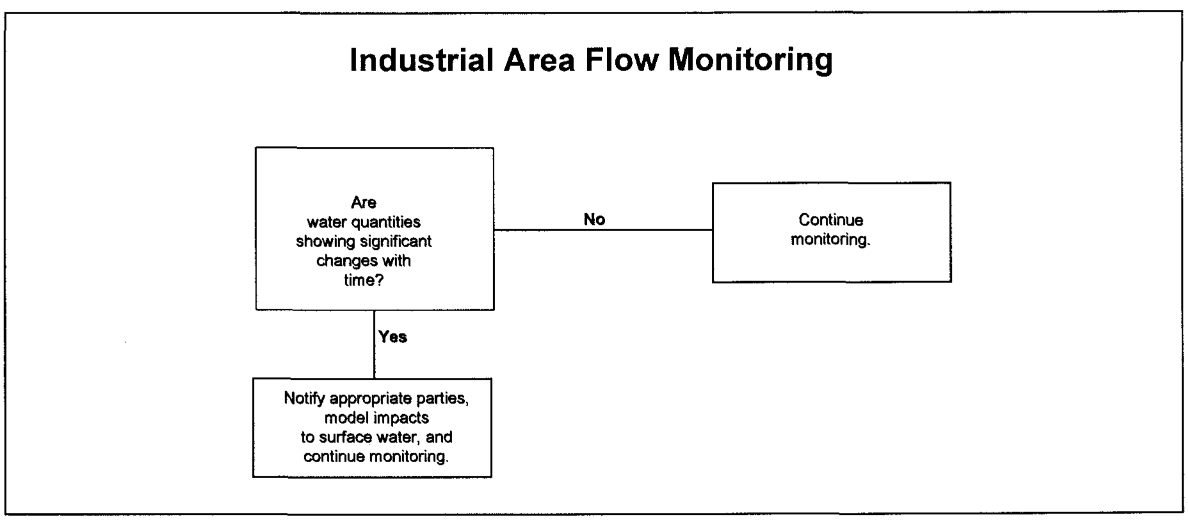
Decision Statement:

IF Groundwater levels show significant change with time—

THEN Notify appropriate parties and model effects on surface water quality and quantity using background water level data as appropriate,

ELSE Continue taking measurements.

Logic:



170

3.4.3.4 Background Groundwater Flow Monitoring

Problem Statement:

Are effects on surface water due to Site activities or natural climatic processes?

Problem Scope:

Background quantity, velocity, and direction of groundwater flow must be measured so that the effects of natural climatic or off-Site variations can be filtered out of the evaluations of the effects of Site actions on groundwater.

Inputs:

- Water level measurements;
- Event monitoring water level measurements; and
- Meteorological data.

Boundaries:

Spatial: Decisions will be made on an individual well basis.

Temporal: Data will be reviewed quarterly and decisions will be made annually.

Decision Statement:

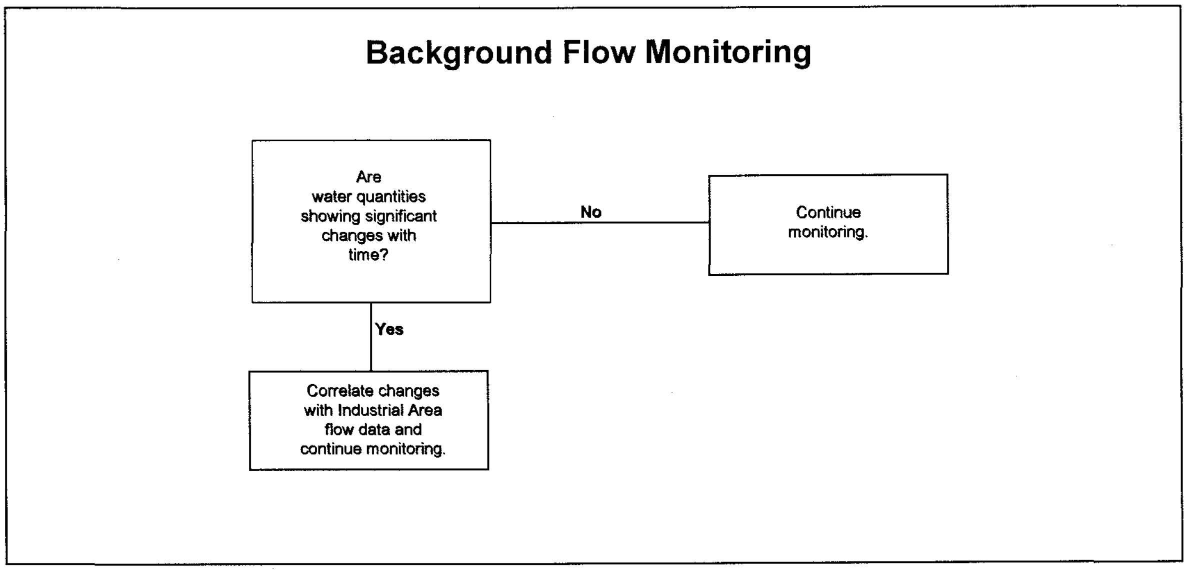
IF Site-wide groundwater elevations show significant changes with time that might cause significant impact surface water quantity—

THEN Evaluate changes in groundwater flow measurements with respect to background flow,

ELSE Continue monitoring.

1711

Logic:



3.4.4 Monitoring Frequencies to Meet DQOs

Hydrogeologic interpretation of the sampling media and statistical treatment of existing data sets determine the sample frequency required to meet the DQOs. Sampling frequency should reflect both the velocity that groundwater is moving through the aquifer and professional judgement. Aquifer tests conducted on wells at the Site have provided general estimates of flow velocity in geologic formations. Appendix C to this section gives relative hydraulic conductivities for groundwater in the various geologic units on Site. Groundwater flow in the Rocky Flats Alluvium and colluvium, which are the dominant components of the UHSU, averages 100 to 200 feet per year. Given these rates, a sampling frequency of twice a year would be able to detect a 50- to 100-foot excursion of contaminants. Because most monitoring wells are located 500 to 1,000 feet from major drainages, detection at this frequency would provide adequate time to evaluate and remediate a moving contaminant plume.

The historic variability of groundwater monitoring data can be used to help determine whether a particular sample represents actual changes in the concentration of contaminants. The EPA's Decision Error Feasibility Trials (DEFT) Program can be used to evaluate the expected performance of various sample frequencies based on DQO constraints, assuming that the decision will be based on a comparison of a mean value to an action level. Using two kinds of data (historical data for several wells to obtain estimates of variability, and preliminary limits on decision errors developed during the DQO process) suggest that two to four samples per year adequately determine exceedances of the RFCA action levels. These preliminary investigations, therefore, support the biannual sampling scheme that is proposed.

3.5 Quality Control Objectives for Collection/Evaluation of Groundwater Data

DOE Order 5400.1 *General Environmental Protection Program* (DOE, 1988) requires that a quality assurance (QA) program be developed consistent with DOE Order 5700.6C, *Quality Assurance*. The program must cover all environmental activities and describe the requirements, methods, and responsibilities of environmental management, staff, contractors, and vendors for achieving and ensuring quality. General requirements for the Groundwater Monitoring Program activities are covered under the RMRS Quality Assurance Program Description (QAPD) and associated operating procedures (OPs).

The Site management structure showing organizational responsibilities is illustrated in Figure 3-2. The organization has been structured to maintain quality for the duration of the program. Conformance to the applicable plan, operating procedures, and established requirements will be verified by personnel not directly responsible for performing the work. Issues identified during implementation of the plan will be tracked and closed out through the Site-wide Commitments Management Program (SCMP). Data (operating procedure forms, logbooks, analytical results, and other quality related information as deemed) will be managed in accordance to the Environmental Restoration Management Administrative Procedure RM-06.02, which governs records capture and transmittal, as described in the SWD data management plan. Work-controlling documents are controlled per Operating Procedure ERM Administrative Procedure 2-G01-ER-ADM-06.01 which governs document control.

The RMRS QAPD requires quality control (QC) for the collection and analysis of environmental samples. The major requirements include the following:

- Developing DQOs;
- Collecting and analyzing samples according to approved procedures; and
- Reducing and reporting data in a controlled manner.

DQOs, sampling design and analysis, and ultimate conclusions about groundwater at the Site are based on judgmental sampling (Gilbert, 1987) and consensus decision making (among, for example, RMRS, Kaiser-Hill, DOE, RFFO, CDPHE, and EPA Region VIII). DQOs, conclusions, and decisions are documented through reports, memos, and meeting minutes.

The following documents provide guidance to QA at the Site:

- *The Data Quality Objectives Process* (EPA, 1994).
- *Data Quality Objectives for Remedial Response Activities Development Process* (EPA, 1987).
- *Guidance for Data Usability in Risk Assessment* (EPA, 1990).

- *Rocky Flats Plant Data Management Plan for Environmental Restoration Management Program* (EG&G, 1994d).

- *Evaluation of Environmental Restoration Management Data for Usability in Final Reports* (EG&G, 1994e).

For nonroutine groundwater investigation activities, the types of data, level of detail, and the data quality needed are determined by the DQOs specified for each data collection activity. OU- or IHSS-specific remedial investigations require DQOs with the primary goal of risk assessment and remediation. OU- and IHSS-specific DQOs are established in the work plan or in the QA addenda for that project.

For those data collection activities where project-specific DQOs are not developed, general groundwater DQO guidance is as follows:

- For precision, field duplicates will be collected at a rate of 5% (one in 20 samples), with a relative percent difference not to exceed 30 percent.

- For accuracy, the analytical method and detection or quantitation limits used for each groundwater analyte will be those specified in Analytical Services' *Statement of Work for Analytical Measurement, General Laboratory Requirements* (Kaiser-Hill, 1996), or provided with the instruments in the case of field measurements. Justification for deviation from the project-specific plan must be provided, along with a determination of whether the actual number of samples collected will be adequate for the end use. Laboratory analyses will be independently validated at 25% of the sample population, unless otherwise specified.

- For representativeness, the actual sample types and quantities collected are compared with those planned for the project. Justification for deviation from the project plan must be provided, as must a determination that the actual number of samples collected will be adequate for the end use.

- For completeness, 90% of the groundwater samples and associated QC samples planned for the groundwater monitoring program must be collected.

- Field QC samples will be collected at the rate of 5% (1 in 20 samples) for equipment rinsates and preservation blanks, and will be compared to the real sample using EPA's 5%/10% criterion. Ambient condition blanks are important when groundwater is sampled in areas close to possible sources of volatile organic contamination, such as areas with gasoline engines operating.

3.5.1 Field Data Collection

QC objectives for the collection of field parameters and representative samples of groundwater are established to ensure that data are of sufficient quality to support the decisions identified in the previous section.

The QC objectives for field data collection are the following:

- Sampled water represents formation water;
- Sampling techniques do not introduce contaminants to samples or wells;
- All sampling techniques are standardized to ensure reproducibility and comparability of results; and
- Water elevations are measured precisely enough to detect minor fluctuations in the water table.

3.5.1.1 Representative Samples

All sampling devices are designed to collect representative samples that reflect actual formation conditions. Well productivity is also a factor since some alluvial and bedrock formations at the Site produce so little water that they dewater while purging. Recharge water becomes aerated while cascading along the inner wall of the well casing, which may alter the chemistry of the collected water. Therefore, specific recharge volumes and sampling times have been established that produce samples most closely representing formation conditions.

In addition, micropurging will be used in wells where there is sufficient sample volume to use a dedicated bladder pump. Micropurging collects the sample at a slow enough rate so that turbulence is reduced and limited drawdown is maintained in the well. Use of the dedicated pump also limits the aeration of the sample before it is placed in the sample bottle.

3.5.1.2 Minimization of Contamination During Sampling

Operating procedures are written to ensure that proper techniques are used to collect samples. The groundwater series of OPs describes sampling techniques that minimize operator-induced contamination. All downwell sampling equipment is made of inert materials. Techniques for the use and decontamination of this equipment ensure a high level of sample integrity and minimize the potential for cross-contamination of samples or contamination of any well with foreign materials. One rinsate sample is collected for every 20 wells sampled. These analyses are routinely checked to ensure that sample equipment does not cross-contaminate wells.

175

3.5.1.3 Standardization of Sampling Techniques

Standardization of sampling methodology is ensured by Site standard OPs. These OPs ensure consistency and standardization of sample collection, data entry, field parameter measurements, sample packaging and shipping, and equipment decontamination. Procedures are updated regularly to reflect any changes to the methodology of sample collection, and distribution of procedures is controlled to ensure that work is performed to the most current version of the procedure.

The RMRS/ER OPs (EG&G, 1991a, b, c) that are required to perform the groundwater monitoring tasks have been approved by CDPHE and EPA. Adherence to the directions set forth in these OPs for field operations (FO), groundwater (GW), and geotechnical (GT) activities should produce data that are representative of groundwater quality, comparable from well to well, and reproducible for any given well at the Site.

The collection of groundwater from a new location involves the planning, permitting, and installation of an engineered well. OPs are used at the Site for siting, installing, and sampling wells containing groundwater (EG&G, 1991a, b, c). The applicable OPs are partitioned into three groups (A, B, and C) (Table 3-1) and generally arranged in order of performance. Several of the OPs will be followed more than once (e.g., transmittal of field QA records following completion of a documentable field technical procedure).

All field sampling crews are trained in the techniques described in the OPs, and standardized equipment is used during the sampling events. This uniformity of sampling crews eliminates sampling variability, and samples collected during any quarter can be compared without concern about field inconsistencies.

Adherence to procedures is ensured by both self-assessment audits by project management and formalized audits by the Site health, safety, and quality organizations.

One field duplicate sample is collected for every 20 wells sampled. Field duplicates are used to assess the consistency of sample collection techniques.

3.5.2 Accuracy of Water Level Measurement

Water elevations are taken in accordance with OP GW.1, Water Level Measurements (EG&G, 1991b). Water level measurements are taken by each member of the sampling crew and compared. In addition, total depth of the well is measured to determine whether sediment has collected in the bottom of the well. Wells that contain large amounts of sediment are targeted for redevelopment. Event-related water level measurements may be collected with a continuous data electronic logging device.

1716

Table 3-1
Operating Procedures for Planning, Installing and Sampling a Groundwater Monitoring Well

A. Planning

OP No.	Procedure
GT.6	Monitoring Well and Piezometer Installation
GT.18	Surface Geophysical Surveys
GT.10	Borehole Clearing
FO.16	Field Radiological Measurements
GT.24	Approval Process for Construction Activities on or Near Individual Hazardous Substance Sites

B. Installation

OP No.	Procedure
FO.4	Heavy Equipment Decontamination
FO.12	Decontamination Facility Operations
FO.11	Field Communications
GW.5	Field Measurement of Groundwater
GT.2	Drilling and Sampling Using Hollow-Stem Auger Techniques
GT.4	Rotary Drilling and Rock Coring
FO.14	Field Data Management
FO.7	Handling of Decontamination Water and Wash Water
FO.6	Handling of Personal Protective Equipment
GT.3	Isolating Bedrock from Alluvium with Grouted Surface Casing
GT.6	Monitoring Well and Piezometer Installation
GW.2	Well Development
FO.8	Handling of Drilling Fluids and Cuttings
FO.10	Receiving, Labeling, and Handling Environmental Materials Containers
FO.23	Management of Soil and Sediment Investigative Derived Material (IDM)
FO.2	Transmittal of Field Quality Assurance Records
GT.1	Logging Alluvial and Bedrock Material
GT.11	Plugging and Abandonment of Wells
GT.15	Geophysical Borehole Logging
GT.39	Push Subsurface Soil Sampling

177

Table 3-1 (Continued)

C. Sampling

OP No.	Procedure
FO.15	Photoionization Detectors (PIDs) and Flame Ionization Detectors (FIDs)
GW.1	Water Level Measurements in Wells and Piezometers
GW.6	Groundwater Sampling
FO.5	Handling of Purge and Development Water
FO.3	General Equipment Decontamination
FO.13	Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
FO.25	Shipping Limited Quantities of Radioactive Materials in Samples

3.5.3 Laboratory Analysis

Standardization of laboratory analysis is established through Analytical Services' *Statement of Work for Analytical Measurement, General Laboratory Requirements* which presents the approved analytical methods, holding times, detection limits, and reporting procedures for laboratories performing analytical work (Kaiser-Hill 1996b). Standardization of analytical results allows information generated from different laboratories to be used interchangeably for decision making.

General chemistry samples are typically sent to laboratories approved by the EPA Contract Laboratory Program (CLP). Radiochemistry samples are sent to labs that are licensed to analyze for radionuclides. Groundwater samples are analyzed at prequalified analytical laboratories both on and off the Site. The QA/QC for any non-CLP and non-radiochemistry samples parallels CLP protocol to include continuous equipment calibrations and method blanks for every one in ten samples. The CLP-type analysis is outlined in Section 2.4 of Analytical Services' *Statement of Work for Analytical Measurement, General Laboratory Requirements* (Kaiser-Hill, 1996b). Analytical Services audits laboratories that analyze the Site groundwater samples. The SWD ensures that data are complete and accurate as they are archived into the database by performing automated error checks of the electronic laboratory deliverables. One hundred percent of all analytical data currently undergo a verification review by Analytical Services. At a minimum, 25% of the analytical data produced receives an independent laboratory validation by a subcontractor. This percentage may be reduced in the future to a statistically significant percentage, upon approval of the regulatory agencies.

3.5.4 Data Management

All field data and laboratory analyses performed for groundwater monitoring are maintained in the SWD. This is a relational database that holds all groundwater, surface water, soil, and borehole data collected on Site. All data analysis and reporting are done with data extracted from SWD.

SWD uses Oracle® (registered trademark of Oracle Company) software for data management and retrieval. It compiles water quality data, field parameter data, sample tracking data, and water level data for groundwater, surface water, boreholes, soils, and sediment samples. Field parameter data (sample location, sample date, pH, turbidity, conductivity, and temperature) are included as are groundwater level measurements and chemical information [Chemical Abstracts Service (CAS) registry numbers, analytical results, and detection limits]. Specific procedures for verification of database information received from subcontractors, or input directly into SWD, have been developed and are being implemented. These procedures provide QA documentation, which ensures that all available data have been incorporated and entered or uploaded properly into SWD. Data integrity is maintained with standard OPs and standardized error checking routines used when loading data into SWD. Other procedures are being developed for database system security and software change control.

The field data gathered on Site is entered through the DATACAP field data entry system. This system is a data entry module that is compatible with the SWD database, and can be used in remote field locations by field personnel. Data entered into DATACAP is verified and signed off by the subcontractor before it is delivered to the main SWD database.

Spatial information for groundwater is located in the RMRS/ER geographic information system (GIS) system. This system uses ARC/INFO® (registered trademark of ESRI) software to store and present locational data for well locations, potentiometric surfaces, plume configurations, topographic contours, and Site facilities.

All well and borehole log information is maintained in the Geoscience Group's Logger Database. The Logger Database has graphic logs of all boreholes and wells on Site, and displays well construction details and geologic information. Subsurface geologic correlations are displayed using Earth Vision® (registered trademark of Dynamic Graphics Incorporated) Software.

3.5.5 Groundwater Assessment and Reporting

Part of the data assessment process is to establish that the data are of the requisite precision, accuracy, representativeness, comparability, and completeness (PARCC parameters) to give accurate evaluations for decision making (data usability). Definitions of the PARCC parameters and further information on the establishment of project-specific DQOs are found in the preceding sections.

3.6 Description of the Groundwater Monitoring Program Resulting from the DQO Process

Groundwater monitoring is an essential function of surface water protection at the Site, since the majority of groundwater becomes surface water within the Site boundaries. The overall objective is to identify contaminated groundwater and associated pathways to surface water, and protect those resources from further or potential damage. The goal is to assess the quality and quantity of groundwater resources in the vicinity of the Site to enable proper management of those resources.

Elements of the program include measurement of hazardous constituent concentrations in groundwater, determination of the gradient and direction of groundwater flow, and assessment of the nature and extent of any contaminant plumes in the UHSU within the Site boundaries. The monitoring network is designed to monitor areas of known or suspected groundwater contamination based on composite groundwater plume information and OU-specific source characterization activities. Composite plume maps are presented in Plate 3.

The monitoring well network should undergo constant evaluation to determine the most effective approach to monitoring groundwater at the Site. This evaluation should take into account current regulations and agreements, but, more important, it should integrate new data and technical information on the nature and extent of Site contamination.

The proposed monitoring program comprises the following monitoring components:

- A network of 100 wells sampled on a semiannual basis;
- A network of 14 well and seeps sampled quarterly;
- Monthly measurement of water elevations at 67 wells;
- Quarterly measurement of water elevations at 89 wells;
- Semiannual measurement of water elevations at 93 wells;
- Real-time measurement of water elevations in 32 wells;
- A program plan for updating and proposing changes to the groundwater monitoring program;
- Annual evaluation and reporting to the appropriate regulatory and community agencies;
- Quarterly reporting of groundwater data that exceed action levels;

180

- A groundwater modeling capability;
- A well control program;
- A well abandonment, replacement, and maintenance program; and
- Other special projects pertinent to groundwater assessment.

The groundwater monitoring network at the Site comprises the following seven categories of monitoring wells:

- Plume definition;
- Plume extent;
- Drainage;
- Boundary;
- Performance;
- D&D;
- RCRA; and
- Plume degradation.

Well categories and wells of the groundwater monitoring network are described in Appendix E of this section (Well List).

3.6.1 Groundwater Monitoring Network

The current DQO evaluation process has prompted a review of the groundwater monitoring program and the determination of specific decisions for each well that is monitored. The general premise is that each well should provide data for a decision or action that is prompted when set criteria are met. At present, groundwater monitoring data are acted on only when they exceed specified action levels for analytes listed in the RFCA ALF document. The list of regulated analytes in RFCA is extensive. Historic data and Site knowledge have been used to determine which contaminants are of major concern in Site groundwater. Table D-1 summarizes the chemicals of concern associated with the various groundwater plumes described in Appendix D of this section. The analyte suites tested for in water from current monitoring wells include the identified chemicals of concern.

\481\

The RFCA analyte lists for groundwater use concentration levels that may differ from the Site-specific levels used in the past. Major contaminants of concern were determined after reviews of historic groundwater data. The inorganic and radionuclide data for each well were initially screened against background concentrations using the 99/99 Upper Tolerance Limits reported in the Background Characterization Report (EG&G, 1993b). The data were then screened against the action levels in the ALF and exceedances were noted for each well. Table D-1 shows the results of this data screening and was used to determine the analyte suite for the wells in the program. The wells were then associated with the IHSS or plume source area where the groundwater contamination originated. Areas were delineated based on the known plumes and potential area of influence for those plumes. Area-specific monitoring suites were then derived. Appendix E to this section contains the analyte suites that will be collected for each well.

3.6.2 Sampling and Analysis

The operational groundwater sampling network will contain 100 wells, the majority of which will monitor the extent of various contaminant plumes. Appendix E lists the wells in the monitoring program along with their well classification. Appendix E also lists the sampling frequency for wells in the program. A semiannual schedule of sampling and analysis of water quality in Site wells has been chosen to generate data representative of the various groundwater conditions and to ensure compliance with applicable groundwater regulations. The frequency of sampling wells used for other purposes (such as performance monitoring and D&D monitoring) will be derived from compliance documents, agreements, or controlled work plans.

A data collection schedule will be adopted for the sampling network. This will ensure that samples for any particular well are collected as closely as possible to semiannual intervals. The schedule is used as a guide (except as required by specific regulations) and may be modified as needed to account for unplanned changes that occur during the sampling quarter.

The following are guidelines for the collection of groundwater samples:

- For bailed wells, filtered samples will be collected for metals analyses and uranium isotopes; unfiltered samples will be collected for organics analyses, water quality, and all other radionuclides. For micropurged wells, samples will not be filtered.

- Well-site field parameters measured are temperature, pH, specific conductance, turbidity, and alkalinity. Total dissolved solids will be measured as either a laboratory parameter or a field parameter.

- If limited groundwater sample volumes prevent analysis of the entire analyte list, the analyses will be performed in the following order in accordance with RMRS/ER OP GW.6 Groundwater Sampling (EG&G, 1991a):

1. CLP Method 524.2 VOCs;
2. Semivolatile organic compounds (SVOCs);
3. Pesticides/polychlorinated biphenyls (PCBs);
4. Nitrate/nitrite, as nitrogen;
5. Radiation screen;
6. Metals—Target Analyte List (TAL), with cesium, lithium, strontium, tin, molybdenum, and silica;
7. Specific metals—list of metals specific to a given well;
8. Uranium-233/234, -235, -238;
9. Strontium-89/90;
10. Plutonium-239/240, americium-241;
11. Major anions (chloride, fluoride, sulfate, carbonate/bicarbonate); and
12. Tritium.

This order in which analyses are to be performed may be altered to fit specific characterization or statistical needs or work plan specifications.

3.6.3 Measurement of Groundwater Elevations

Preparation of water elevation maps and hydrographs addresses both a regulatory requirement and a technical need to know groundwater flow directions and gradients accurately. The measurement of groundwater elevations has been designed to produce data that are as representative of current conditions as possible. These water level measurements are collected within 10 working days of the period designated for measurement, so that the data are as temporally related as possible.

Based on the DQO for each activity, Appendix E lists the frequency of water level measurement proposed for the components of the Site-wide Groundwater Flow Monitoring Program.

3.6.4 Groundwater Reporting

Groundwater activities will be reported throughout the life of the Site monitoring program. Reports will be transmitted to EPA and CDPHE as the responsible parties listed in the DQO decision statements in Section 3.4.2, after review and approval by DOE.

The following basic reporting vehicles are required for the groundwater program based on the integration of past regulatory requirements with the RFCA ALF.

3.6.4.1 Annual Report

An annual assessment of groundwater conditions is required in the DQO decisions in this document, the Industrial Area IM/IRA, and in the regulations governing RCRA interim status units and municipal landfills (6 CCR 1007). Therefore, this report will incorporate the data elements that were historically reported in the RCRA Annual Groundwater Report, Well Evaluation Reports, and IM/IRA reports. This annual report will replace these latter reports and will be the primary compliance report for groundwater monitoring. This integrated report will contain the following elements:

- A general description of the various monitoring program elements, including any new monitoring or sampling activities.
- Interpretation of the geochemical data generated from the year's sampling with respect to action levels and trends that may show contaminant movement. Where documented exceedances exist, the report will evaluate the need for further actions and propose those activities.
- Interpretation of the Site groundwater flow-through analysis of water level data collected by use of hydrographs, potentiometric surface maps, and modeling, where appropriate.
- Recommendations for improvements to the monitoring program that may include changes in the well network, analytes collected, and sampling frequency.

In general, reports on potential exceedances for wells will use the following methodology:

Plume Definition Wells:

- Data will first be compared with Tier I Action Levels for groundwater. If an action level has been exceeded for any analyte that has an action level, data will then be compared with background values using the mean + 2 standard deviations established in the 1993 Background Characterization Report (EG&G, 1993a).
- If both the action level and background levels have been exceeded for an analyte that has not had consistent historic exceedances, an evaluation will be proposed. Remediation and/or management decisions will be made based on the results of the evaluation.
- If a particular contaminant has been detected consistently above the Tier I Action Level in historic data, then the result will be plotted against historic data set for

184

that analyte and that well. If the analytical results show an increasing trend in concentration over a two-year period with respect to the historic data set, then an evaluation will be proposed and remedial priority established.

For purposes of data analysis the historic data set is defined as the data generated for a particular well from the years 1991-1995. If a well does not have this data set, or is a newer well, the historic data set will be all data generated for the well until a five-year data set is reached.

Plume Extent, Tier II, Drainage, and Boundary Wells:

- Data will be compared with Tier II Action Levels for groundwater. If an action level has been exceeded for an analyte, data will then be compared with background values using the mean + 2 standard deviations, established in the 1993 Background Characterization Report (EG&G, 1993a).

- If both the action level and background level have been exceeded by an analyte that has not had consistent historic exceedances, monthly sampling will be performed per RFCA. An evaluation will be proposed to determine the impact to surface water. Remediation and/or management decisions will be made based on the results of the evaluation.

- If a particular analyte has been detected consistently above the Tier II Action Level and background in historic data, a check will be made to see if an evaluation of impact to surface water has been performed. If no evaluation has been performed, an evaluation will be proposed. If an evaluation has been performed, then future monitoring results will be tested against an historic data set of values for that analyte and that well. If the result is higher than the background mean + 2 standard deviations with respect to the historic data set, then another evaluation will be proposed to assess impacts to surface water.

Building D&D Monitoring Wells:

- Performance wells may be existing monitoring wells or special wells installed to detect any unplanned excursion of contaminants during a building D&D activity. Where there is a groundwater concern, a baseline should be established for water quality before D&D activities begin. The baseline should be established one year prior to the D&D action and should be composed of a minimum of four sample events. After the baseline is established, any exceedances above the baseline mean + 2 standard deviations will be reported. Trend plots may be used to track concentrations where exceedances are determined. The results of building specific decisions may also be addressed in the Industrial Area IM/IRA annual report.

185

Performance Monitoring Wells:

- Performance wells may be existing monitoring wells or special wells installed to measure the effectiveness of a source removal or plume treatment system. In each case, it is assumed that the wells that will be used already exceed Tier I or Tier II Action Levels. Therefore, the trend in concentration with time is the best measure of performance. Trend plots will be constructed to track whether contaminant concentrations change with time. A performance monitoring activity may also be described in separate closure documents for that source area.

RCRA Monitoring Wells:

- The reporting of monitoring wells used for a permitted RCRA facility are prescribed in the state and federal regulations. Reporting will follow the requirements of these regulations and associated guidance documents. The results of unit-specific monitoring requirements may also be addressed in specific annual reports. An example of this is the annual report for the Existing Landfill.

The annual report will provide the results of monitoring on a calendar year basis. The annual report will be submitted to the DOE at the end of the fiscal year in which the calendar year ended. This date is typically September 30. DOE will review and transmit the report to the regulatory agencies by November 15.

3.6.4.2 RFCA Quarterly Reporting

Quarterly reporting of groundwater analyses is currently required for 1) RCRA interim status units, 2) the boundary wells under the Agreement in Principal, and 3) the French drain monitoring wells under the IM/IRA for the French Drain, and a RFCA ALF document.

The RFCA quarterly report for groundwater will replace all previous quarterly reports and integrate all the various reporting elements into a standardized evaluation, using the action levels as a means of assessing results. The report will summarize the data collected and any exceedances of standards that have occurred using the methods outlined in the previous section. Because semiannual sampling is proposed, the quarterly reports will present only those data that have been analyzed and uploaded into SWD in time for the report. The report for any calendar quarter will be compiled 60 working days after the end of the quarter to allow time for laboratory analysis, data upload, and evaluation. The reports will be issued and presented at the next Quarterly Information Exchange Meeting following the 60-day compilation period. Summary results from the data evaluation will be submitted to DOE, EPA, and CDPHE one week prior to the Quarterly Information Exchange Meeting.

186

3.6.5 Evaluation of Groundwater Impacts To Surface Water

Many of the DQO decisions for groundwater monitoring require that the effect of potential groundwater contamination on surface water be evaluated. In many cases, when groundwater action levels are exceeded, confirmatory samples will be taken. If analyses of follow-up samples confirm an exceedance, or if historic data indicate an impact to surface water that has not been evaluated, an evaluation will be performed. In general, the evaluation phase will result in a focused data quality objective that will determine two things: the type of data that need to be collected, and the methodology for determining the nature and extent of contamination and its effect on surface water. The Plume Management Template in Section 3.1.5 outlines the role of plume evaluations in the overall Plume Management Strategy.

3.6.6 Groundwater Flow Modeling

Computer modeling of the groundwater system at the Site is a valuable tool for characterizing the groundwater flow regime and determining the fate of potential contaminants introduced into the groundwater system. The primary purpose of groundwater modeling is to integrate geologic, hydrogeologic, and geochemical characterization data into numerical representations of the groundwater system. These models provide predictive capabilities that can be used to analyze and design a groundwater monitoring network, and to evaluate how groundwater affects surface water.

This plan proposes that the current groundwater flow model and supporting software and graphic coverages should be maintained and updated; they are used in problem-solving and tracking how Site closure activities affect the environment. The activity would update and maintain the input grids and coverages for modeling so that real-time simulations can be run when potential impacts to the environment are discovered. Numeric modeling will be used if it is established that the project merits a numeric solution. This will be decided during the DQO development phase of the evaluation.

An annual status report for the maintenance and update of the groundwater flow model, including the results of any modeling performed, will be incorporated into the RFCA Annual Report.

3.6.7 Well Control Program

The Well Control Program is currently a Site Level 1 administrative procedure for new well and piezometer installations (EG&G, 1994a). The procedure is implemented through the RMRS/ER Groundwater Group. The Well Control Program ensures that proper recording and tracking of all well installation activities on Site are done, and serves as a necessary approval process for the installation of wells. The program will support the following activities:

- Assigning well location codes to eliminate misidentification of wells or use of redundant well names.

187

- Maintaining a database with summary well information to be used for evaluation of the functions of new wells, and preparing and obtaining well permits as required by 2 CCR 402-2 regulations. The instructions and form are available in the Environmental Management Department OP GT.6 1994 revision (EG&G, 1991a).

- Maintaining a database of well construction information and geologic log information that must be submitted with the permit applications.

- Submitting to the State Engineer's Office permits for wells that are installed or abandoned.

- Maintaining the Site geologic core repository for use in correlation of geologic strata and interpretation of hydrogeologic properties.

- Through an approval process before well construction, ensuring that wells are installed following applicable procedures and with appropriate knowledge of geologic and Site conditions.

3.6.8 Well Abandonment and Replacement

In certain cases, the usefulness of a groundwater monitoring well is exceeded by its potential liability. Such wells should be considered for abandonment or, in certain cases, replacement. Abandoning a well eliminates it from the monitoring network in such a manner that the well will not remain a conduit for groundwater or contaminant migration. Installation and monitoring procedures have been established to minimize the need for abandonments. However, well abandonment is a necessary component of the Groundwater Monitoring Program. Damaged wells must also be abandoned.

This IMP proposes that proper abandonment of wells be required under the following circumstances:

- When the potential for cross-contamination from the well exists;

- When the well is poorly constructed or of unknown construction;

- When the well is in the way of proposed construction or demolition activities; and

- When the well has been damaged.

A report describing the results of the Well Abandonment and Replacement Program (WARP), including well installations, abandonments and replacements, will be included as a section in the RFCA Annual Report.

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189

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190

APPENDIX A

Site Description and Environmental History

List of Figures

List of Tables

192

A.1 Site Description

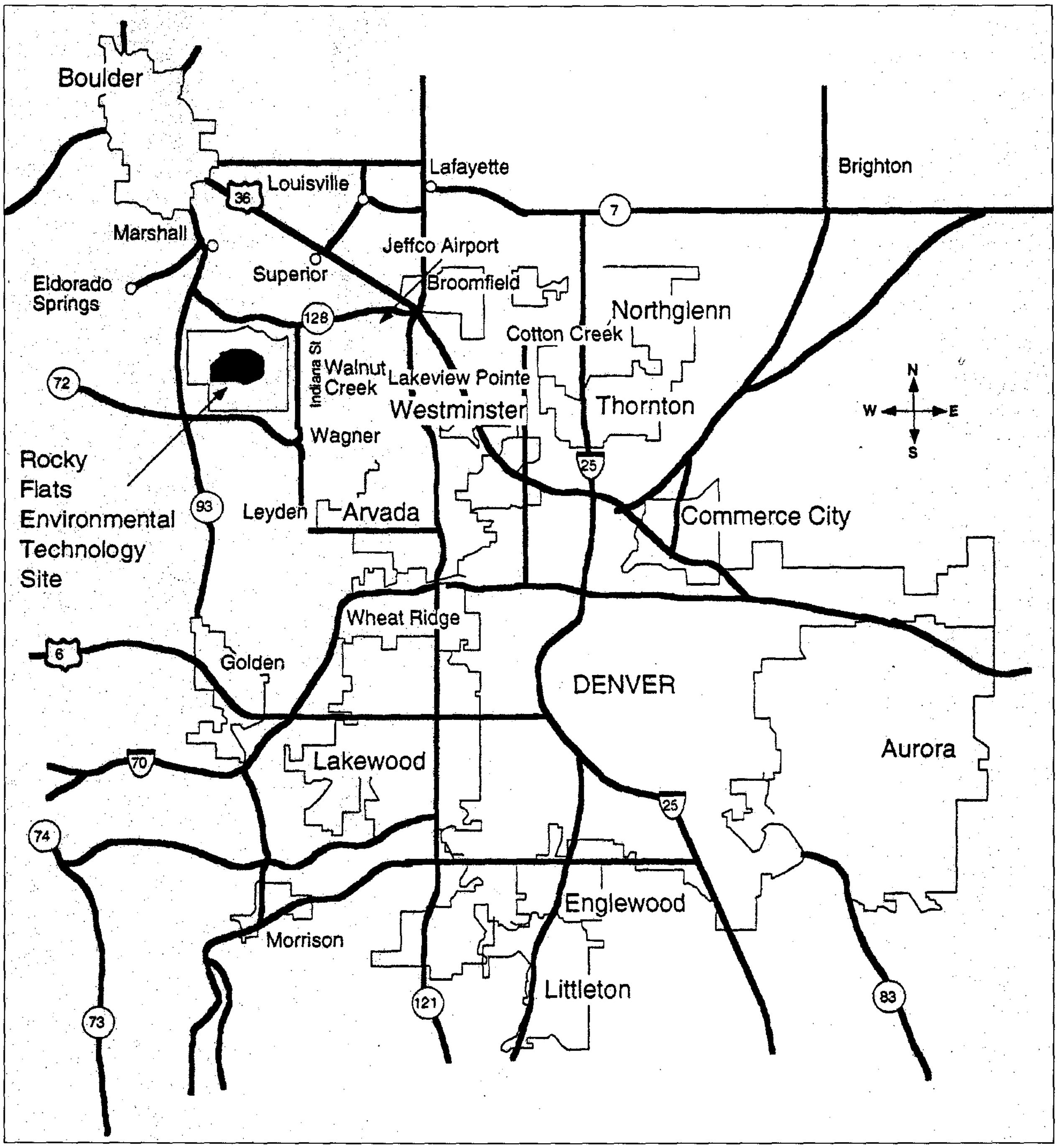
Rocky Flats Environmental Technology Site (RFETS or the Site) is located 16 miles northwest of Denver in Jefferson County, Colorado, and is situated within a 50-mile radius of 2.1 million people. The Site encompasses approximately 6,550 acres of federally-owned land (Figure A-1). Ownership, however, does not include surface and subsurface minerals or water rights. The Site is a U.S. government-owned and contractor-operated facility. Site construction was initiated in 1951 and operations began in 1952 (DOE, 1992).

RFETS was part of the nationwide nuclear weapons research, development, and production complex governed by its original mission. The plant produced metal components for nuclear weapons from plutonium (Pu), uranium (U), beryllium (Be), and stainless steel. Other production activities included chemical recovery and purification of recyclable transuranic radionuclides, metal fabrication and assembly, and related quality control functions. The plant conducted research and development programs in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry, and physics. Parts manufactured at the Site were shipped off Site for final assembly.

Major plant structures, including all production buildings, are located within a 400-acre Industrial Area (Figure A-2), with a 6,150-acre Buffer Zone that surrounds the Industrial Area. Industrial activity immediately adjoining the Site includes present and/or prior coal and clay mining, petroleum recovery, natural classified-aggregate quarrying, and fabricated-aggregate mining. Other activities include cattle ranching and wind energy research. Several irrigation ditches intersect the Site, transmitting water for downstream agricultural, industrial, and municipal purposes. Three ephemeral streams drain the Site and flow eastward.

The Site operations have generated solid and liquid nonhazardous, hazardous, radioactive, and mixed (hazardous and radioactive) waste streams. These wastes have been handled and disposed of in a variety of ways. Solid nonhazardous and nonradioactive wastes are disposed of at the Site landfill. Hazardous and mixed radioactive wastes are present on Site and recycled, stored on Site, or shipped off Site for recycling, treatment, or disposal.

Figure A-1
General Location Map



194

A.2 Environmental History

Processing and fabrication of weapons-related components began at the Site in 1952. At that time, environmental protection measures were established that seemed consistent with prudent environmental management. However, some activities resulted in the environmental contamination of portions of the Site. Efforts to document the extent of Site contamination are in progress, in accordance with the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the *Rocky Flats Cleanup Agreement* (RFCA) (DOE et al, 1996), a cooperative agreement between the Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and Colorado Department of Public Health and Environment (CDPHE). In addition, an Historical Release Report (HRR) (DOE, 1992) has been developed that documents knowledge gained to date about contamination arising from past practices. The HRR is updated annually to document any changes in status for known spills and contaminant sources.

A.2.1 Definition and Description of Contaminated Sites

Section 3004(u) of the RCRA requires that all Solid Waste Management Units (SWMUs) be identified. This became applicable to the Site with the signing of the Compliance Agreement between the State of Colorado and DOE, on July 31, 1986 (State of Colorado, 1986). The exact definition of SWMUs had not been formalized. Therefore, the Site used guidance from the State of Colorado and EPA Region VIII (EPA, 1985). The State of Colorado and EPA required the identification of all areas where releases to the environment may have occurred, including hazardous waste and nonhazardous waste. Also included were single-release areas and locations where long-term management of waste may have occurred.

The SWMUs were initially identified in the *Comprehensive Environmental Assessment and Response Program (CEARP) Phase I: Installation Assessment* (DOE, 1985). The SWMUs consisted of inactive waste disposal sites, accidentally contaminated sites, and sites found to pose potential environmental concern due to past or current waste management practices. Inspections were conducted on each site. The first identification of SWMUs [now titled Individual Hazardous Substance Sites (IHSSs)], consistent with the guidance provided by the State of Colorado, was presented as an appendix to the November 1986, RCRA, Part B Permit Application (Rockwell, 1986).

The SWMUs at the Site were renamed as IHSSs in the Interagency Agreement (IAG), which became the compliance document for Site cleanup under RCRA and CERCLA (State of Colorado, 1991). The term IHSS is specific to the Site and is defined in the IAG (Section 3.2.8) as ". . . locations associated with a release or threat of release of hazardous substances which may cause harm to human health and/or the environment ...".

Once the IHSSs were identified, they were grouped into Operable Units (OUs). The IHSSs were grouped based on cleanup priorities, waste type, and geographic setting into 16 OUs, as defined in the IAG. Under RFCA, the OUs have since been consolidated to eliminate redundant paperwork and to streamline the CERCLA remediation process.

Table A-1 lists IHSSs for each OU. Figure A-3 shows the IHSSs and their locations relative to the original 15 OUs located within the Site. Investigations of off-Site contamination beyond the Site boundary were investigated under OU3, which encloses 38 square miles and is not shown on Figure A-3.

These IHSSs have been investigated according to schedules presented in the IAG (State of Colorado, 1991).

The IHSS list is updated as new IHSSs are identified in the HRR (DOE, 1992). Each IHSS is considered a potential source of environmental contamination and, therefore, a potential source of contamination to groundwater.

Table A-1
Individual Hazardous Substance Sites

IHSS NO.	PAC NO.	PAC NAME
101*	000-101	Solar Ponds
102	800-102	Oil Sludge Pit
103	800-103	Chemical Burial
104	800-104	Liquid Dumping
105.1	800-105.1	Westernmost Out-of-service Fuel Tanks
105.2	800-105.2	Easternmost Out-of-service Fuel Tanks
106	800-106	Outfall
107	800-107	Hillside Oil Leak
108	900-108	Trench T-1
109	900-109	Trench T-2
110	NE-110	Trench T-3
111.1	NE-111.1	Trench T-4
111.2	NE-111.2	Trench T-5
111.3	NE-111.3	Trench T-6
111.4	NE-111.4	Trench T-7
111.5	NE-111.5	Trench T-8
111.6	NE-111.6	Trench T-9
111.7	NE-111.7	Trench T-10
111.8	NE-111.8	Trench T-11
112	900-112	903 Pad
113	900-113	Mound Area
114*	NW-114	Present Landfill
115	SW-115	Original Landfill
116.1	400-116.1	West Loading Dock, Building 447 (IAG Name: West Loading Dock Area)
116.2	400-116.2	South Loading Dock, Building 444 (IAG Name: South Loading Dock Area)
117.1	500-117.1	North Site Chemical Storage
117.2	500-117.2	Middle Site Chemical Storage
117.3	600-117.3	South Site Chemical Storage
118.1	700-118.1	West of Building 730 Solvent Spill
118.2	700-118.2	South End of Building 776 Solvent Spill
119.1	900-119.1	West Scrap Metal Storage Area (IAG-Name: West Area Solvent Spill)
119.2	900-119.2	East Scrap Metal Storage Area (IAG-Name: East Area Solvent Spill)
120.1	600-120.1	Fiberglassing Area North of Building 664
120.2	600-120.2	Fiberglassing Area West of Building 664

199

Table A-1
(continued)

IHSS NO.	PAC NO.	PAC NAME
121*	000-121	Original Process Waste Lines
122*	400-122	Underground Concrete Tanks
123.1*	700-123.1	Valve Vault 7
123.2	700-123.2	Valve Vault West of Building 707
124.1*	700-124.1	30,000 Gallon Tank (Tank #68)
124.2*	700-124.2	14,000 Gallon Tank (Tank #66)
124.3*	700-124.3	14,000 Gallon Tank (Tank #67)
125*	700-125	Holding Tank (Tank #66)
126.1	700-126.1	Westernmost Out-of-service Waste Tank
126.2	700-126.2	Easternmost Out-of-service Waste Tank
127	700-127	Low-level Radioactive Waste Leak
128	300-128	Oil Burn Pit No. 1
129*	400-129	Oil Leak
130	900-130	Radioactive Site - 800 Area Site No. 1
131	700-131	Radioactive Site - 700 Area Site No. 1
132*	700-132	Radioactive Site - 700 Area Site No. 4
133.1	SW-133.1	Ash Pit I-1
133.2	SW-133.2	Ash Pit I-2
133.3	SW-133.3	Ash Pit I-3
133.4	SW-133.4	Ash Pit I-4
133.5	SW-133.5	Incinerator
133.6	SW-133.6	Concrete Wash Pad
134	300-134 & 300-134.2	Metal Disposal Site North Area (IAG Name: Lithium Metal Destruction Site) & Reactive Metal Destruction Site South Area
135	300-135	Cooling Tower Blowdown
136.1	400-136.1	Cooling Tower Pond West of Building 444 (IAG Name: Cooling Tower Pond Northeast Corner of Building 460)
136.2	400-136.2	Cooling Tower Blowdown Building 444 (IAG Name: Cooling Tower Pond West of Building 460)
137	700-137	Cooling Tower Blowdown Buildings 712 and 713 (IAG Name: Cooling Tower Blowdown Building 774)
138	700-138	Cooling Tower Blowdown Building 779
139.1	700-139.1	Hydroxide Tank Area Spill
139.2	700-139.2	Hydrofluoric Acid Tanks Spill
140	900-140	Hazardous Disposal Area (IAG Name: Reactive Metal Destruction Site)

200

Table A-1
(continued)

IHSS NO.	PAC NO.	PAC NAME
141	900-141	Sludge Dispersal
142.1	NE-142.1	A-1 Pond
142.10	SE-142.10	C-1 Pond
142.11	SE-142.11	C-2 Pond
142.12	NE-142.12	Flume Pond (IAG Name: A-5 Pond)
142.2	NE-142.2	A-2 Pond
142.3	NE-142.3	A-3 Pond
142.4	NE-142.4	A-4 Pond
142.5	NE-142.5	B-1 Pond
142.6	NE-142.6	B-2 Pond
142.7	NE-142.7	B-3 Pond
142.8	NE-142.8	B-4 Pond
142.9	NE-142.9	B-5 Pond
143	700-143	Old Outfall - Building 771 (IAG Name: Old Outfall)
144	700-144	Sewer Line Overflow (IAG Name: Sewer Line Break)
145	800-145	Sanitary Waste Line Leak
146.1	700-146.1	7,500 Gallon Tank (31)
146.2	700-146.2	7,500 Gallon Tank (32)
146.3	700-146.3	7,500 Gallon Tank (34W)
146.4	700-146.4	7,500 Gallon Tank (34E)
146.5	700-146.5	7,500 Gallon Tank (30)
146.6	700-146.6	7,500 Gallon Tank (33)
147.1	700-147.1	Process Waste Line Leaks (IAG Name: Maas) Area
147.2	800-147.2	Building 881 Conversion Activity Contamination (IAG: Name: Owen Area)
148	100-148	Waste Spills
149	700-149	Effluent Pipe
150.1	700-150.1	Radioactive Site West of Building 771 (IAG: Name: Radioactive Leak North of Building 771)
150.2	700-150.2	Radioactive Site West of Building 771 (IAG Name: Radioactive Leak West of Building 771)
150.3	700-150.3	Radioactive Site Between Buildings 771 & 774 (IAG Name: Radioactive Leak Between Buildings 771 & 774)
150.4	700-150.4	Radioactive Site Northwest of Building 750 (IAG Name: Radioactive Leak East of Building 750)

201

Table A-1
(continued)

IHSS NO.	PAC NO.	PAC NAME
150.5	700-150.5	Radioactive Site West of Building 707 (IAG Name: Radioactive Leak West of Building 707)
150.6	700-150.6	Radioactive Site South of Building 779 (IAG Name: Radioactive Leak South of Building 779)
150.7	700-150.7	Radioactive Site South of Building 776 (IAG Name: Radioactive Leak South of Building 776)
150.8	700-150.8	Radioactive Site Northeast of Building 779 (IAG Name: Radioactive Leak Northeast of Building 779)
151	300-151	Fuel Oil Leak
152	600-152	Fuel Oil Tank
153	900-153	Oil Burn Pit No. 2
154	900-154	Pallet Burn Site
155	900-155	903 Lip Area
156.1	300-156.1	Building 334 Parking Lot
156.2	NE-156.2	Soil Dump Area
157.1	400-157.1	Radioactive Site North Area
157.2	400-157.2	Radioactive Site South Area
158	500-158	Radioactive Site - Building 551
159	500-159	Radioactive Site - Building 559
160	600-160	Radioactive Site Building 444 Parking Lot
161	600-161	Radioactive Site West of Building 664
162	000-162	Radioactive Site - 700 Area Site No. 2
163.1	700-163.1	Radioactive Site 700 Area Site No. 3 Wash Area
163.2	700-163.2	Radioactive Site 700 Area Site No. 3 Buried Slab
164.1	600-164.1	Radioactive Site 800 Area Site No. 2 Concrete Slab
164.2	800-164.2	Radioactive Site 800 Area Site No. 2 Building 886 Spills
164.3	800-164.3	Radioactive Site 800 Area Site No. 2 Building 889 Storage Pad
165	900-165	Triangle Area
166.1	NE-166.1	Trench A
166.2	NE-166.2	Trench B
166.3	NE-166.3	Trench C
167.1	NE-167.1	Spray Field: North Area
167.2	NE-167.2	Spray Field: Pond Area (Center Area)
167.3	NE-167.3	Spray Field: South Area
168*	SW-168	West Spray Field

202

Table A-1
(continued)

IHSS NO.	PAC NO.	PAC NAME
169	500-169	Waste Drum Peroxide Burial
170*	NW-170	PU&D Storage Yard - Waste Spills
171	300-171	Solvent Burning Ground
172	000-172	Central Avenue Waste Spill
173	900-173	South Dock - Building 991 (IAG Name: Radioactive Site - 900 Area)
174*	NW-174	PU&D Container Storage Facilities (2)
175*	900-175	S&W Building 980 Contractor Storage Facility
176*	900-176	S&W Contractor Storage Yard
177*	800-177	Building 885 Drum Storage Area
178*	800-178	Building 881 Drum Storage Area
179*	800-179	Building 865 Drum Storage Area
180*	800-180	Building 883 Drum Storage Area
181*	300-181	Building 334 Cargo Container Area
182*	400-182	Building 444/453 Drum Storage Area
183	900-183	Gas Detoxification Area
184	900-184	Building 991 Steam Cleaning Area
185	700-185	Solvent Spill
186*	300-186	Valve Vault 12
187	400-187	Sulfuric Acid Spill [IAG Name: Acid Leaks (2)]
188	300-188	Acid Leak
189	600-189	Multiple Acid Spills 218 Tanks (IAG Name: Multiple Acid Spills)
190	000-190	Caustic Leak
191	400-191	Hydrogen Peroxide Spill
192	000-192	Antifreeze Discharge
193	400-193	Steam Condensate Leak
194	700-194	Steam Condensate Leak
195	NW-195	Nickel Carbonyl Disposal
196	100-196	Water Treatment Plant Backwash Pond
197	500-197	Scrap Metal Sites
203*	NW-203	Inactive Hazardous Waste Storage Area
204*	400-204	Original Uranium Chip Rowster
205*	400-205	Building 460 Sump No. 3 Acid Side
206*	300-206	Inactive D-836 Hazardous Waste Tank
207*	400-207	Inactive 444 Acid Dumpster
208*	400-208	Inactive 444/447 Waste Storage Area
209	SE-209	Surface Disturbance Southeast of Building 881

IHSS NO.	PAC NO.	PAC NAME
210*	900-210	Unit 16, Building 980 Cargo Container
211*	800-211	Building 881 Drum Storage Unit 26
212*	300-212	Building 371 Drum Storage Unit 53
213*	900-213	Unit 15, 904 Pad Pondcrete Storage
214*	700-214	750 Pad Pondcrete and Saltcrete Storage, Unit 25
215*	700-215	Tank T-40, Unit 55.13
216.1	NE-216.1	Easy Spray Fields - North Area
216.2	NE-216.2	East Spray Fields - Center Area
216.3	NE-216.3	East Spray Fields - South Area
217*	800-217	Building 881, CN Bench Scale Treatment, Unit 32

Notes:

"*" indicates IHSSs that are RCRA units per the Interagency Agreement that was signed in 1991. IHSS 198 was deleted in 1990.

199	=	Contamination of the Land Surface
200	=	Great Western Reservoir
201	=	Standley Lake Reservoir
202	=	Mower Reservoir
IAG	=	Interagency Agreement
PAC	=	Personnel Access Control
PU&D	=	Property Utilization and Disposal

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205

APPENDIX B

Action Level Framework for Groundwater

Analyte	CAS No.	Tier 1- 100 x MCLs (mg/L)	Tier 2- MCLs (mg/L)
Acenaphthene (V)	83-32-9	2.19E+02	2.19E+00
Acetone (V)	67-64-1	3.65E+02	3.65E+00
Aldrin	309-00-2	5.00E-04	5.00E-06
Aluminum	7429-90-5	1.06E+04	1.06E+02
Anthracene (V)	120-12-7	1.10E+03	1.10E+01
Antimony	7440-36-0	6.00E-01	6.00E-03
Aroclor-1016	12674-11-2	5.00E-02	5.00E-04
Aroclor-1221	11104-28-2	5.00E-02	5.00E-04
Aroclor-1232	11141-16-5	5.00E-02	5.00E-04
Aroclor-1242	53469-21-9	5.00E-02	5.00E-04
Aroclor-1248	12672-29-6	5.00E-02	5.00E-04
Aroclor-1254	11097-69-1	5.00E-02	5.00E-04
Aroclor-1260	11096-82-5	5.00E-02	5.00E-04
Arsenic	7440-38-2	5.00E+00	5.00E-02
Barium	7440-39-3	2.00E+02	2.00E+00
Benzene (V)	71-43-2	5.00E-01	5.00E-03
alpha-BHC	319-84-6	1.35E-03	1.35E-05
beta-BHC	319-85-7	4.72E-03	4.72E-05
gamma-BHC (Lindane)	58-89-9	2.00E-02	2.00E-04
Benzo(a)anthracene	56-55-3	1.16E-02	1.16E-04
Benzo(a)pyrene	50-32-8	2.00E-02	2.00E-04
Benzo(b)fluoranthene	205-99-2	1.16E-02	1.16E-04
Benzo(k)fluoranthene	207-08-9	1.16E-01	1.16E-03
Benzoic Acid	65-85-0	1.46E+04	1.46E+02
Benzyl Alcohol	100-51-6	1.10E+03	1.10E+01
Beryllium	7440-41-7	4.00E-01	4.00E-03
bis(2-Chloroethyl)ether (V)	111-44-4	1.63E-03	1.63E-05
bis(2-Chloroisopropyl)ether (V)	108-60-1	4.22E-02	4.22E-04
bis(2-Ethylhexyl)phthalate	117-81-7	6.00E-01	6.00E-03
Bromodichloromethane (V)	75-27-4	1.00E+01	1.00E-01
Bromoform (V)	75-25-2	1.00E+01	1.00E-01
Bromomethane (V)	74-83-9	1.09E+00	1.09E-02
2-Butanone (V)	78-93-3	2.47E+02	2.47E+00
Butylbenzylphthalate	85-68-7	7.30E+02	7.30E+00
Cadmium	7440-43-9	5.00E-01	5.00E-03
Carbon disulfide (V)	75-15-0	2.76E+00	2.76E-02
Carbon tetrachloride (V)	56-23-5	5.00E-01	5.00E-03
alpha-Chlordane	5103-71-9	2.00E-01	2.00E-03
beta-Chlordane	5103-74-2	2.00E-01	2.00E-03
gamma-Chlordane	5103-74-2	2.00E-01	2.00E-03
4-Chloroaniline	106-47-8	1.46E+01	1.46E-01
Chlorobenzene (V)	108-90-7	1.00E+01	1.00E-01
Chloroethane (V)	75-00-3	2.78E+03	2.78E+01
Chloroform (V)	67-66-3	1.00E+01	1.00E-01
Chloromethane (V)	74-87-3	2.32E-01	2.32E-03
2-Chloronaphthalene (V)	91-58-7	2.92E+02	2.92E+00
2-Chlorophenol (V)	95-57-8	1.83E+01	1.83E-01

208

Analyte	CAS No.	Tier 1- 100 x MCLs (mg/L)	Tier 2- MCLs (mg/L)
Chromium	7440-47-3	1.00E+01	1.00E-01
Chrysene	218-01-9	1.16E+00	1.16E-02
Cobalt	7440-48-4	2.19E+02	2.19E+00
Copper	7440-50-8	1.30E+02	1.30E+00
Cyanide	57-12-5	2.00E+01	2.00E-01
4,4-DDD	72-54-8	3.54E-02	3.54E-04
4,4-DDE	72-55-9	2.50E-02	2.50E-04
4,4-DDT	50-29-3	2.50E-02	2.50E-04
Dalapon	75-99-0	2.00E+01	2.00E-01
Dibenz(a,h)anthracene	53-70-3	1.16E-03	1.16E-05
Dibromochloromethane	124-48-1	1.01E-01	1.01E-03
1,2-Dibromo-3-chloropropane	96-12-8	2.00E-02	2.00E-04
Di-n-butylphthalate	84-74-0	3.65E+02	3.65E+00
2,4-D	94-75-7	7.00E+00	7.00E-02
1,2-Dichlorobenzene (V)	95-50-1	6.00E+01	6.00E-01
1,3-Dichlorobenzene (V)	541-73-1	6.00E+01	6.00E-01
1,4-Dichlorobenzene (V)	106-46-7	7.50E+00	7.50E-02
3,3-Dichlorobenzidine	91-94-1	1.89E-02	1.89E-04
1,1-Dichloroethane (V)	107-06-2	1.01E+02	101E+00
1,2-Dichloroethane (V)	107-06-2	5.00E-01	5.00E-03
1,1-Dichloroethene (V)	540-59-0	7.00E-01	7.00E-03
1,2-Dichloroethene (total)(V)	540-59-0	7.00E+00	7.00E-02
2,4-Dichlorophenol	120-83-2	1.10E+01	1.10E-01
1,2-Dichloropropane (V)	78-87-5	5.00E-01	5.00E-03
cis-1,3-Dichloropropene (V)	1006-01-5	1.27E-02	1.27E-04
trans-1,3-Dichloropropene (V)	10061-02-6	1.27E-02	1.27E-04
Dieldrin	60-57-1	5.31E-04	5.31E-06
Diethylphthalate	84-66-2	2.92E+03	2.92E+01
2,4-Dimethylphenol (V)	105-67-9	7.30E+01	7.30E-01
Dimethylphthalate	131-11-3	3.65E+04	3.65E+02
2,4-Dinitrophenol	51-28-5	7.30E+00	7.30E-02
2,4-Dinitrotoluene	121-14-2	7.30E+00	7.30E-02
2,6-Dinitrotoluene	606-20-2	1.25E-02	1.25E-04
Di-n-octylphthalate	117-84-0	7.30E+01	7.30E-01
Endosulfan I	959-98-8	2.19E+01	2.19E-01
Endosulfan II	33213-65-9	2.19E+01	2.19E-01
Endosulfan sulfate	1031-07-8	2.19E+01	2.19E-01
Endosulfan (technical)	115-29-7	2.19E+01	2.19E-01
Endrin (technical)	72-26-8	2.00E-01	2.00E-03
Ethylbenzene (V)	100-41-4	7.00E+01	7.00E-01
Fluoranthene	206-44-0	1.46E+02	1.46E+00
Fluorene (V)	86-73-7	1.46E+02	1.46E+00
Fluoride	16984-48-8	4.00E+02	4.00E+00
Glyphosate	1071-83-6	7.00E+01	7.00E-01
Heptachlor	76-44-8	4.00E-02	4.00E-04
Heptachlor epoxide	1024-57-3	2.00E-02	2.00E-04
Hexachlorobenzene	118-74-1	1.00E-01	1.00E-03
Hexachlorobutadiene	87-68-3	1.09E-01	1.09E-03
Hexachlorocyclopentadiene	77-47-4	5.00E+00	5.00E-02
Hexachloroethane	67-72-1	6.07E-01	6.07E-03
Indeno(1,2,3-cd)pyrene	193-39-5	1.16E-02	1.16E-04

209

Analyte	CAS No.	Tier 1- 100 x MCLs (mg/L)	Tier 2- MCLs (mg/L)
Isophorone	78-59-1	8.95E+00	8.95E-02
Lithium	7439-93-2	7.30E+01	7.30E-01
Manganese	7439-96-5	1.83E+01	1.83E-01
Mercury	7439-97-6	2.00E-01	2.00E-03
Methoxychlor	72-43-5	4.00E+00	4.00E-02
Methylene chloride (V)	75-09-2	5.00E-01	5.00E-03
4-Methyl-2-pentanone (V)	108-10-1	2.03E+01	2.03E-01
2-Methylphenol	95-48-7	1.83E+02	1.83E+00
Molybdenum	7439-98-7	1.83E+01	1.83E-01
Naphthalene (V)	91-20-3	1.46E+02	1.46E+00
Nickel	7440-02-0	1.00E+01	1.00E-01
Nitrate (MCL as N)	1-005	1.00E+03	1.00E+01
Nitrite (MCL as N)	1-005	1.00E+02	1.00E+00
Nitrobenzene (V)	98-95-3	4.20E-01	4.20E-03
n-Nitrosodiphenylamine (V)	86-30-6	1.73E+00	1.73E-02
n-Nitrosodipropylamine	621-64-7	1.21E-03	1.21E-05
Pentachlorophenol	87-86-5	1.00E-01	1.00E-03
Phenol	108-95-2	2.19E+03	2.19E+01
Pyrene	129-00-0	1.10E+02	1.10E+00
Selenium	7782-49-2	5.00E+00	5.00E-02
Silver	7440-22-4	1.83E+01	1.83E-01
Strontium	7440-24-6	2.19E+03	2.19E+01
Styrene (V)	100-42-5	1.00E+01	1.00E-01
Sulfate	14808-79-8	5.00E+04*	5.00E+02*
1,1,2,2-Tetrachloroethane (V)	79-34-5	8.95E-03	8.95E-05
Tetrachloroethene (V)	127-18-4	5.00E-01	5.00E-03
Thallium	7440-28-0	2.00E-01	2.00E-03
Tin	7440-31-5	2.19E+03	2.19E+01
Toluene (V)	108-88-3	1.00E+02	1.00E+00
Toxaphene	8001-35-2	3.00E-01	3.00E-03
1,2,4-Trichlorobenzene (V)	120-82-1	7.00E+00	7.00E-02
1,1,1-Trichloroethane (V)	71-55-6	2.00E+01	2.00E-01
1,1,2-Trichloroethane (V)	79-00-5	5.00E-01	5.00E-03
Trichloroethene (V)	79-01-6	5.00E-01	5.00E-03
2,4,5-Trichlorophenol	95-95-4	5.00E+00	5.00E-02
2,4,6-Trichlorophenol	88-06-2	7.73E-01	7.73E-03
Vanadium	7440-62-2	2.56E+01	2.56E-01
Vinyl acetate	108-05-4	3.65E+03	3.65E+01
Vinyl chloride (V)	75-01-4	2.00E-01	2.00E-03
Xylene (total)(V)	1330-20-7	1.00E+03	1.00E+01
Zinc	7440-66-6	1.10E+01	1.10E+01

Analytes without an MCL value list the corresponding residential groundwater ingestion Preliminary Programmatic Remediation Goal (PPRG) which is shown in bold italics
Analytes without an MCL or a PPRG value are not listed
(V) = Volatile chemicals
*Based on proposed MCL

210

APPENDIX B

Action Level Framework for Groundwater

Analyte	CAS No.	Tier 1- 100 x MCLs (pCi/L)	Tier 2- MCLs (pCi/L)
RADIOLOGIC PARAMETERS			
Americium-241	14596-10-2	1.45E+01	1.45E-01
Cesium-137+D	10045-97-3	1.51E+02	1.51E+00
Plutonium-239	10-12-8	1.51E+01	1.51E-01
Plutonium-240	10-12-8	1.51E+01	1.51E-01
Radium-226+D	13982-63-3	2.00E+03*	2.00E+01*
Radium-228+D	15262-20-1	2.00E+03*	2.00E+01*
Strontium-89	11-10-9	4.62E+02	4.62E+00
Strontium-90+D	11-10-9	8.52E+01	8.52E-01
Tritium	10028-17-8	6.66E+04	6.66E+02
Uranium-233+D	11-08-5	2.98E+02	2.98E+00
Uranium-234	11-08-5	1.07E+02	1.07E+00
Uranium-235+D	15117-96-1	1.01E+02	1.01E+00
Uranium-238+D	7440-61-1	7.68E+01	7.68E-01

D = Daughters
*Based on proposed MCL

211

APPENDIX C

Physical And Hydrologic Setting

List of Figures

C.1 <u>Geology</u>

C.1.1 Introduction

Rocky Flats Environmental Technology Site (RFETS or the Site) is situated approximately 2 to 6 miles east of the Front Range of Colorado (Figure A-1) on the western margin of the Colorado Piedmont section of the Great Plains Physiographic Province (Spencer, 1961). The geologic history of the Rocky Mountain region of Colorado (which includes the Site area) has been summarized by Haun and Kent (1965). The elevation at the Site is approximately 6,000 feet above mean sea level (msl). The Industrial Area (main facility area) of the Site is located on alluvial-covered pediment. The upper surface of the alluvium slopes easterly one to two degrees. Most of the surrounding area in the Buffer Zone is more prominently dissected with intermittent streams. These small, eastward flowing streams include Rock Creek, Walnut Creek, Woman Creek, and several surface water diversion ditches (see Section 3.1.4 of this report, Figure 3-1).

The following major geologic and hydrologic parameters influence groundwater flow at the Site (EG&G, 1995a):

- Topography controls the surface waters of the upslope drainage basin that, in part, recharges groundwater and the three principal streams draining the Site. The majority of shallow groundwater is intercepted by these drainages.

- The lithology and permeability of the unconsolidated surficial deposits permit meteoric waters to recharge the water table. The water table is contained in alluvium and weathered bedrock.

- Paleotopography of the bedrock pediment, which is less permeable than the overlying unconsolidated surficial deposits, serves to focus groundwater movement along bedrock "lows."

- Paleoweathering of shallow bedrock materials has enhanced the permeability of the upper 10 to 60 feet relative to unweathered bedrock.

- The permeability of bedrock units, composed primarily of claystone with lesser amounts of siltstone and sandstone, is generally several orders of magnitude less than for unconsolidated surficial deposits. The 600+ feet of unweathered bedrock between the shallow groundwater flow system and deep regional Laramie-Fox Hills aquifer provides an effective barrier to vertical groundwater and contaminant movement.

C.1.2 Stratigraphy

The stratigraphic sequence that underlies the Site extends from the crystalline Precambrian gneiss, schist, and granitoids at 3,000 feet below msl to the unconsolidated Quaternary deposits at surface approximately 6,000 feet above msl. Based upon aerial photographic interpretation,

214

field geologic mapping, coal and aggregate mine development, petroleum exploration in the vicinity, and numerous borehole investigations, a substantial amount of lithologic information has been gained about the Site. The generalized lithologic section in the Rocky Flats area is shown in Figure C-1.

Bedrock formations from the uppermost Cretaceous Pierre, Fox Hills, Laramie, and Arapahoe Formations are present and exposed at the surface and beneath the Site. The Quaternary Rocky Flats Alluvium, and to a limited extent Verdos Alluvium, unconformably overlie the Cretaceous Arapahoe and Laramie Formations in the central portion of the Site. The unconsolidated surficial deposits, combined with the weathered portion of subcropping bedrock formations, form the sequence of rocks which have the greatest importance regarding groundwater flow and contaminant transport at the Site.

C.1.2.1 Pediment-Covering Alluviums

Several Quaternary alluvial formation pediment covers have been identified in the vicinity of the Site by Scott (1975). The Rocky Flats Alluvium is an unconsolidated deposit derived from quartzites and granites of the Coal Creek Canyon provenance west of the Site. The deposit diminishes from west to east with thicknesses ranging from approximately 100 feet to less than 1 foot. In the central portion of the Site, the deposit is approximately 15 to 25 feet thick. The Rocky Flats Alluvium is a heterogeneous deposit dominantly composed of angular to subrounded, poorly-sorted, coarse, bouldery-gravel with a clay and sand matrix. Clay, silt, and sand lenses as well as varying amounts of caliche are also present. Exposures of Rocky Flats Alluvium in the aggregate quarries north and west of the Site exhibit some large scale cross-stratification. Depositional processes include fluvial and debris-flow transport (Shroba, 1994) infilling paleotopographic lows but leaving a widespread surface of erosion with extremely low relief.

C.1.2.2 Other Surficial Deposits

In addition to the pediment-forming alluvial deposits, younger Quaternary units consisting of colluvium, landslide alluvium, and valley fill alluvium mantle the hillslopes and valley bottoms below the pediment surface. Colluvial deposits are derived from Arapahoe and Laramie Formations and older alluvial deposits. This unit consists of sheetwash, soil creep, and landslide materials in a total thickness of 3 to 16 feet (Shroba, 1994). These deposits locally flank the Rocky Flats Alluvium and generally extend to lower parts of the slopes along the principal drainages.

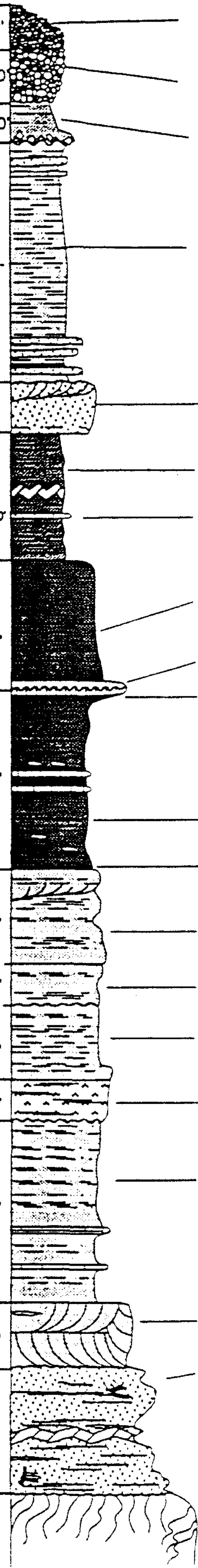
Landslide deposits more commonly flank the Rocky Flats Alluvium. They are often bounded by headwall scarps and lobate toes at the downslope margins. Seeps issuing from the base of the Rocky Flats Alluvium contribute to landslide colluvium generation. The landslide units include earth flows, slumps, and debris flows in a thickness estimated between 10 to 33 feet (Shroba, 1994).

215

Generalized Stratigraphic Column for the Rocky Flats Area

Formations exposed at RFETS: Quaternary through Fox Hills Sandstone
Formations in subsurface or exposed west of RFETS: Pierre Shale through Precambrian X

Age	Formation	Th.	Description
Quaternary	Verdos Alluvium	0'-12'	Reddish brown matrix, moderately sorted, sandy pebble gravel and pebbly, silty sand
Quaternary	Rocky Flats Alluvium	0'-100'	Reddish brown to yellowish brown matrix, grayish-orange to dark gray, poorly sorted, angular to subrounded, cobbles, coarse gravels, coarse sands and gravelly clays; varying amounts of caliche; aggregate source
Upper Cretaceous	Arapahoe Fm.	0'-120'	Gray to yellowish orange clay stone, sandy clay stone, and clayey sandstone, medium to coarse sandstone and chert pebble conglomerate locally at base; aqurier east of RFETS
Upper Cretaceous	Laramie Formation	600'-800'	Gray, fine- to medium-grained sandstone and clay stones; thin coal beds mined in lower part and locally uraniferous; ironstone nodule; aquifer east of RFETS
Upper Cretaceous	Fox Hills Sandstone	90'-140'	Light olive gray to yellowish brown fine- to medium-grained cross-bedded sandstone, and laminated silty sandstone and shale at base; aquifer east of RFETS
Upper Cretaceous	Pierre Shale	± 7500'	Dark gray, silty bentonitic shale and few thin, silty sandstones Hygiene Sandstone Member in lower part
Upper Cretaceous	Niobrara Formation	350'	Olive gray to dusky yellow, very calcareous shale, thin bentonite, gypsum, and fossiliferous limestone beds Light gray, dense, fossiliferous limestone
Upper Cretaceous	Benton Shale	450'	Yellowish gray, sandy fossiliferous limestone Dark gray shale with bentonite streaks, thin limestones in middle part Dark gray to black, brittle silty shale
Lower Cretaceous (Dakota Group)	South Platte Formation	250'	Light gray, fine- to medium-grained cross-bedded sandstone, dark gray clay stone in middle part;mined for uranium ore; major oil reservoir
Lower Cretaceous (Dakota Group)	Lytle Formation	100'	Light gray to tan, fine- to coarse-grained, locally conglomeratic sandstone, frequent red and green siltstone interbeds
Jurassic	Morrison Formation	250'	Gray to greenish-gray to red shale and siltstone, thin limestones in middle part; lenticular sandstones in upper and lower part; locally uraniferous
Jurassic	Ralston Creek Formation	110'	Light gray siltstone and light red, silty shale; calcareous; chert nodules and beds
Triassic / Permian	Lykins Formation	450'	Red siltstone and clay stone with two laminated limestones in lower part
Permian	Lyons Sandstone	150'	Pinkish-gray, fine- to medium-grained, cross-bedded sandstone; conglomeratic lenses frequent
Pennsylvanian	Fountain Formation	800'	Red, fine- to coarse-grained sandstone and conglomerate, arkosic, thin, lenticular red siltstones frequent throughout
Pre-cambrian	Precambrian X ~1.7 byr		Gneiss, schist, and small granitic intrusions; mined for uranium ore



Modified from LeRoy and Weimer (1971); USGS OFR-94-162 (1994); Nelson-Moore, et al.(1978); and Pearl (1980)

Rocky Flats Environmental Technology Site

Generalized Stratigraphic Column for the Rocky Flats Area

1996 IMP

August 1994 | Figure C-1

M\ES\Fig 4-02 Stratigraphy/ S.M. Stoller

C.1.2.3 Arapahoe Formation

The Arapahoe Formation is composed of claystones and silty claystones with some lenticular sandstones. In the Geologic Characterization Report for the U.S. DOE Rocky Flats Plant (EG&G, 1991), the Arapahoe Formation was interpreted to be 150 feet thick in the central area and to contain five sandstones named Sandstones 1 through 5. The thickest and most widespread, uppermost sandstone was defined as the No. 1 Sandstone which was interpreted to be deposited in a fluvial environment. The more recent Site-wide mapping program (EG&G, 1992) determined that the overall Arapahoe Formation is generally less than 25 feet thick in the Site area. The No. 1 Sandstone (EG&G, 1991) was correlated to the basal Arapahoe Sandstone. Lower bedrock sandstones (i.e., Sandstones 2 through 5) in the 1991 Geologic Characterization Report were redefined as lenticular Laramie sandstones as they are texturally distinct from the No. 1 Sandstone by virtue of their high silt and clay content. These lower sandstones have limited hydrologic significance and are currently identified as part of the upper Laramie Formation.

The No. 1 Sandstone, which is currently defined as the basal Arapahoe Sandstone, is of concern as a potential contamination pathway, especially where it subcrops beneath the alluvial/bedrock unconformity. The other sandstones pose a limited threat as potential contamination pathways since they are lenticular and discontinuous.

C.1.2.4 Laramie and Fox Hills Sandstone Formations

The Laramie Formation is approximately 600 to 800 feet thick and is composed of a lower sandstone/claystone/coal interval and an upper, thicker claystone interval. The permeable lower sandstones and coals of the Laramie, combined with the permeable sandstones of the Fox Hills, constitute a regional aquifer system known as the Laramie-Fox Hills aquifer. This aquifer system is an important water source in the South Platte River Basin (Pearl, 1980), and is the sole water supply for some residents in the Rocky Flats area. The Fox Hills Formation is primarily a fine-grained sandstone with an approximate thickness of between 75 to 125 feet with thin siltstone and claystone interbeds. The Fox Hills Formation outcrops and subcrops along a narrow, north-south trending pattern in the extreme western part of the Site upgradient from known sources of contamination.

C.1.2.5 Pierre Formation

The Pierre Formation is a 7,500-foot thick, dark gray, silty bentonitic shale that acts as a lower confining layer for the Laramie-Fox Hills aquifer in the Denver Basin. This thick marine shale unit subcrops only in the extreme western part of the Site.

C.1.3 Geologic Structure

The Site is located along the western margin of the Denver Basin, an asymmetric basin with a steeply east-dipping western flank and a gentle eastern flank. The interpretation of the

217

subsurface structure is generalized in the east-west geological cross section of the Site area presented in Figure C-2. A monoclinal fold limb exposed west of the Site is the most significant surficial structural feature in the Site area. Along the west limb of the fold, an angular unconformity exists between the Upper Cretaceous bedrock and the base of the Quaternary Rocky Flats Alluvium.

No active faults have been identified at the Site. Several high angle bedrock faults have been inferred to exist in the Industrial Area of the Site based on various stratigraphic and borehole correlation criteria. These faults appear to have only a limited hydrologic significance with regard to vertical groundwater movement and contaminant transport (DOE, 1996).

C.2 Hydrogeology

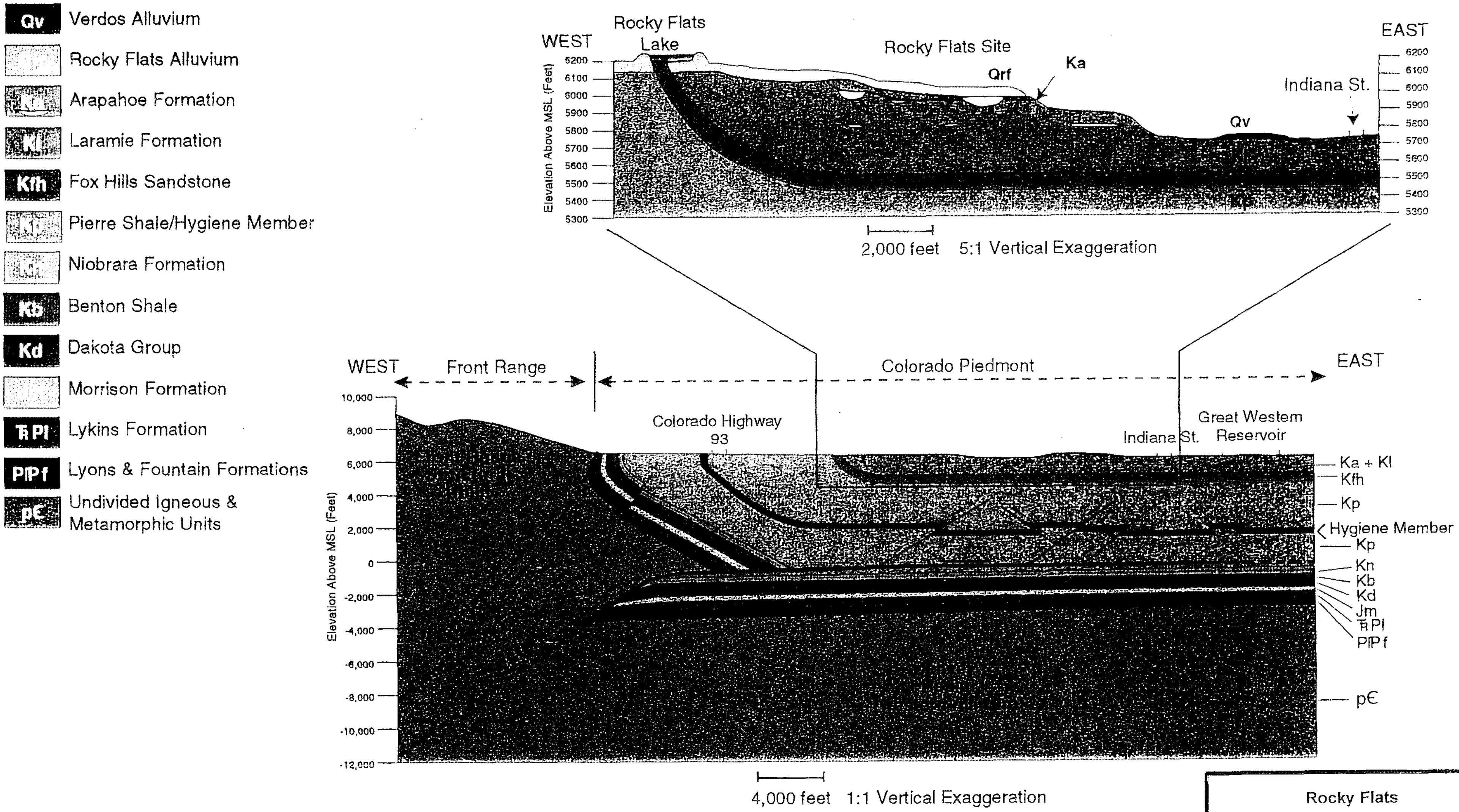
C.2.1 Introduction

This section presents the basic concepts about the hydrogeologic conditions at the Site that affect groundwater monitoring and protection. Characterization of the hydrogeologic setting is based on the currently accepted conceptual geologic and hydrogeologic models described in the Sitewide Geoscience Characterization Study (EG&G, 1995b; Shroba, 1994; EG&G, 1995c). These conceptual geologic and hydrogeologic models are used to predict the direction and rate of groundwater flow, identify potential pathways for contaminant migration, and determine the extent of contaminant plumes given varying physical, chemical, and biological factors.

C.2.2 Definition of the Uppermost Aquifer for the Site

The term "aquifer" as defined by Title 40 of the *Code of Federal Regulations (*CFR) Section 260.10 is a "geologic formation, group of formations, or a part of a formation that is capable of yielding a significant amount of water to a well or spring." An "uppermost aquifer" is defined as "the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's boundary." Geologic materials with similar hydrologic properties comprise a hydrostratigraphic unit (HSU) (Fetter, 1988). For purposes of this report, the uppermost aquifer or upper hydrostratigraphic unit (UHSU) consists of the unconfined saturated zone, in which unconsolidated and consolidated groundwater-bearing strata are in hydraulic communication. The UHSU consists of the following geologic units: Rocky Flats Alluvium, valley-fill alluvium, colluvium, landslide deposits, weathered Arapahoe and Laramie Formation bedrock, and all sandstones within the Arapahoe and upper Laramie Formations in hydraulic communication with the overlying unconsolidated surficial deposits. The UHSU is considered to be equivalent to the uppermost aquifer at the Site.

Geologic Units



Structural interpretation from EG&G, 1993a.

Rocky Flats
Environmental Technology Site

Generalized Geologic Cross Section of the Front Range and the Rocky Flats Area

Geologic Characterization Report

March 1995

Figure C-2

219

Beneath the surficial materials and the consolidated sandstones of the UHSU are the geologic units of the lower hydrostratigraphic unit (LHSU). The LHSU consists of the consolidated, unweathered bedrock zone of the Arapahoe and upper Laramie Formations not in hydraulic communication with the overlying UHSU. The Arapahoe and upper Laramie Formations comprising the geologic units of the LHSU consist of lesser amounts of sandstone and greater amounts of adjacent claystones. Because of the low permeability of the claystones, they behave as aquitards restricting hydraulic communication with the UHSU. The lower Laramie and Fox Hills Formations comprise a stratigraphically lower and third hydrostratigraphic unit beneath the Site.

Groundwaters of the three hydrostratigraphic units are hydraulically separated beneath the Industrial Area of the Site. They do converge, however, and are in mutual contact immediately upgradient near the western margin of the Site due to monoclinal folding and erosional proximity. Initially, background geochemical characterization of the UHSU and LHSU revealed the units as having statistically different groundwater chemistry concurring with the delineation of separate hydrostratigraphic units (EG&G, 1993a). This concept is presently being qualified. In addition, possible communication of the hydrostratigraphic units along other geologic structures is currently being assessed. More detailed differentiation of the LHSU will be achieved as new hydrogeologic and geochemical data are generated from Site investigations currently proposed or in progress.

C.2.3 Groundwater Occurrence and Distribution

The Site is located in a regional groundwater recharge area (EG&G, 1991). Groundwater recharge occurs from the infiltration of incident precipitation and as base flow near the upgradient area of the Site drainage basin, which extends west to Coal Creek. Groundwater recharge occurs from the infiltration of precipitation and from stream, ditch, and pond seepage. Much of the groundwater that discharges from the UHSU to streams and seeps evaporates as it is being discharged. Limited investigation of the former Operable Unit (OU) 2 area during the period of July through October 1993 indicated that the precipitation component of recharge was lost to evapotranspiration demands (EG&G, 1993b).

In the western part of the Site, where the thickness of the Rocky Flats Alluvium reaches 100 feet, the depth to the water table is 50 to 70 feet below the surface. The depth to water generally becomes shallower from west to east as the alluvial material thins and the confining claystones approach the ground surface. At the head of stream drainages and valley sides, seeps are common at the base of the Rocky Flats Alluvium where it is in contact with claystones of the Arapahoe/Laramie Formations, and where Arapahoe Formation sandstone crops out. In general, the unconsolidated surficial materials are thicker in the western, higher elevations at the Site. Accordingly, the saturated thickness of these materials also thins eastward. The potentiometric surface of groundwater in unconsolidated surficial deposits has been mapped and is shown on Plate 2. The period illustrated represents the time of year when static water levels are highest. Extensive areas of unsaturated and seasonally unsaturated alluvium and colluvium are indicated east and northeast of the Industrial Area.

Groundwater in the Arapahoe Formation sandstone units, which subcrop beneath the alluvial material, is not confined when in contact with the surficial materials. In this setting, a hydraulic connection exists between the bedrock sandstone and the alluvial material allowing the bedrock groundwater to exist under unconfined conditions as part of the UHSU. The subcropping Arapahoe Formation No. 1 Sandstone located in the eastern portion of the Industrial Area and in the area between South Walnut Creek and Woman Creek is part of the UHSU (EG&G, 1991). The upper discontinuous sandstones of the Laramie Formation also subcrop beneath alluvium and colluvium, but in limited areas in the valleys and along valley slopes. Groundwater in the lenticular sandstone units of the Laramie Formation occurs under confined conditions over scattered areas of the Site.

Groundwater levels in UHSU wells fluctuate in response to seasonal recharge events. Approximately 15% of the groundwater monitoring wells commonly are dry during at least one of the quarterly sampling events. Of the remaining wells, approximately half cannot yield sufficient water volume (4.5 gallons) specified for laboratory samples. Sampling crews must return later after wells have recovered and obtain additional sample volumes.

C.2.4 Groundwater Flow

The shallow groundwater flow regime at the Site is illustrated by the configuration of potentiometric contours in Plate 2. This map indicates that groundwater flow is largely controlled by the topography of the bedrock surface. Groundwater in the ridge tops generally flows toward the east-northeast. In areas where the ridge tops are dissected by east-northeast trending stream drainages, groundwater flows to the north or south toward the bottom of the valleys. In the valley bottoms, groundwater flows to the east, generally following the course of the stream. Shallow groundwater flow is primarily lateral due to the low permeability of the underlying claystone bedrock.

A potential for vertical groundwater flow, although limited by the low permeability of bedrock claystones, is indicated by the presence of strong downward vertical hydraulic gradients between the UHSU and underlying bedrock units. This situation implies a condition of poor hydraulic communication. For example, vertical gradients on the order of 0.79 to 1.05 feet per foot (ft/ft) have been calculated between colluvial and bedrock sandstones at OU1. The vertical groundwater flux through claystones is assumed to be small, on the order of 10^{-10} to 10^{-7} centimeters per second (cm/sec), based on calculations provided (DOE, 1996). Fracturing, where evident, is most abundant in the weathered bedrock zone, but is observed to decrease with depth in unweathered bedrock. Preferential vertical groundwater flow and contaminant transport along fractures or fault zones do not appear to represent a viable pathway for contaminant migration based on an assessment of available data (DOE, 1996).

C.2.5 Hydraulic Conductivity

The UHSU at the Site has a relatively low to moderate hydraulic conductivity that typically yields small amounts of water to groundwater monitoring wells. The UHSU exhibits a wide range of hydraulic conductivities because of the diverse nature of the individual geologic units

221

that comprise this unit. Summary statistics for UHSU hydraulic conductivities [(EG&G, 1995c) Table G-2] indicate a range of 5.0×10^{-2}cm/sec [3.0×10^{4} feet per year (ft/yr)] to 3×10^{-8}cm/sec (9.3×10^{-1}ft/yr). Listed in order of decreasing geometric mean hydraulic conductivity, the relative ranking of individual units of the UHSU is presented as follows: valley-fill alluvium (2.5×10^{-3}cm/sec); Arapahoe No. 1 sandstone (7.9×10^{-4} cm/sec); Rocky Flats Alluvium (2.1×10^{-4} cm/sec); colluvium (9.3×10^{-5} cm/sec); weathered Laramie Formation sandstones (3.9×10^{-5} cm/sec); and weathered Laramie Formation claystones (8.8×10^{-7} cm/sec). Hydraulic conductivities for LHSU materials are generally the lowest measured at the Site with geometric mean values for individual lithologic groups ranging from 1.6×10^{-7} to 5.8×10^{-7} cm/sec [(11), Table G-2]. The low permeability and 600+ foot thickness of the upper Laramie Formation claystones act as an effective aquitard that restricts downward vertical groundwater flow and contaminant transport to the Laramie-Fox Hills aquifer (DOE, 1996).

C.3 <u>References</u>

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APPENDIX D

Site Impacts to Groundwater

List of Figures

List of Tables

225

D.1 Impact of Individual Hazardous Substance Sites on the Quality of Groundwater

The characterization and assessment of Individual Hazardous Substance Sites (IHSSs) and their potential to impact groundwater and surface water has historically been conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigation/feasibility study (RI/FS) programs for individual Operable Units (OUs). In 1995, the decision was made to take a Site-wide approach to the evaluation and remediation of the Rocky Flats Environmental Technology Site (RFETS or the Site). Of the original 16 OUs, there are only 7 OUs remaining: the Buffer Zone OU; the Industrial Area OU; and OUs 1, 3, 5, 6, and 7. However, groundwater issues will be investigated on a Site-wide basis.

The general conclusions reached with respect to groundwater contamination are that the hydrogeologic setting of a specific area directly affects the movement and quality of groundwater. Chemicals at some of the Site IHSSs have impacted groundwater quality. To characterize this impact, groundwater quality data have been compiled to identify hazardous constituents, determine their concentrations and rate of migration, and delineate the horizontal and vertical extent of potential contaminant plumes. The migration of contaminants can be highly influenced by engineered structures such as buildings, dams, slurry walls, diversion drains, pipelines, and diversion flumes that affect natural, near-surface water movement at the Site.

Because so much of the information dealing with individual IHSSs and contaminant sources is referenced in documents pertaining to the OUs, a short description and references pertinent to the OU where plumes exist is provided in this section. Summaries of groundwater analytical data for determination of historic chemicals of concern is presented in Table D-1.

D.2 Groundwater Contaminant Plumes

Evaluation of geochemical data from groundwater wells sampled as part of the Site-wide monitoring program has delineated a number of areas of groundwater contamination. The most widespread contamination is that of volatile organic compounds (VOCs). Plate 3 shows the distribution of VOC contamination in the upper hydrostatigraphic unit (UHSU). Plume definition is inexact; however, because of limitations in well coverage, variability of hydrostratigraphic conditions, and local variations in groundwater transport velocity. Published plume maps for individual constituents can be found in the 1993 *Well Evaluation Report* (EG&G, 1994a), the annual RCRA groundwater reports [EG&G, 1992, 1993, 1995; Rocky Mountain Remediation Services (RMRS), 1996a], and in individual OU RI/Resource Conservation and Recovery Act (RCRA) feasibility investigation (RFI) reports.

The VOC contaminant plumes in groundwater at the Site have the most potential to impact surface water or to migrate off Site. These plumes have been defined on the basis of exceedances above the maximum contaminant levels (MCL) for individual constituents. To delineate areas of highly contaminated groundwater, the groundwater action levels of 100 times the MCLs were compared against all groundwater data for the most common VOCs in groundwater. The exceedances were plotted and are shown on Plate 3.

226

TABLE D-1
Summary of Potential Chemicals of Concern for Groundwater Plumes

Potential Chemicals Of Concern	Groundwater Contaminant Plumes									
	X = Chemicals > Tier I Levels, X = Chemicals > Tier II Levels, x = Minor Detections > Tier II Levels									
	881 Hillside	903 Pad	Mound	E. Trenches	Solar Ponds	Carbon Tet	Ind. Area	Old LF	PU&D	Present LF
Metals/Indicator Parameters:										
Aluminum	x	x		X	x	x	X	x	X	
Antimony	X	X	X	X	X	X	X	x	x	X
Arsenic						X	x			x
Barium		x		X		x	X	x	x	X
Beryllium	x	X	x	X		X	X	X	X	x
Cadmium	x	X	x	X	X	x	x	x	X	x
Chromium	X	X	x	X		X	X	X	X	X
Cobalt					X					
Copper	x			x			x		x	x
Cyanide				x						
Fluoride	x	x			X	x	x	x	x	x
Lithium				x	X	x				
Manganese	X	X	X	**X**	X		X	X	X	X
Mercury										
Molybdenum	x	x								x
Nickel	X	X	x	X	X	X	X	X		X
Nitrate	X	X		X	**X**		X	x		X
Selenium	X				X		x			x
Silver									x	x
Strontium										
Sulphate	X	X			X					X
Vanadium	x	X		X		X	X	x	X	
Zinc					x					
Radionuclides:										
Americium-241	x	X	x	X	X	X	X			x
Cesium 137		x		x	x	x				
Plutonium-239/240		X	x	X	X	X	X	x	x	x
Strontium 89/90	x				X		x	X		x
Tritium					X					X
Uranium-233/234		x			**X**					
Uranium-235	X	x			X					
Uranium-238		X			X		X	**X**		

227

TABLE D-1
Summary of Potential Chemicals of Concern for Groundwater Plumes

Potential Chemicals Of Concern	Groundwater Contaminant Plumes									
	X = Chemicals > Tier I Levels, X = Chemicals > Tier II Levels, x = Minor Detections > Tier II Levels									
	881 Hillside	903 Pad	Mound	E. Trenches	Solar Ponds	Carbon Tet	Ind. Area	Old LF	PU&D	Present LF
Organic Compounds:										
1,1,1-Trichloroethane									X	
1,1,2-Trichloroethane	X	x	x				X			
1,1-Dichloroethane							**X**	x		
1,1-Dichloroethene	**X**	**X**	x	X		X	**X**	x	X	X
1,2-Dichloroethane			x							
1,2-Dichloroethene	X	X	x				X			
1,2-Di*chloropropane*			x							
2,6-Dinitrotoluene	x									X
4-Methyl-2-Pentanone										X
Acenaphthene										
Acetone		x		x						
Alpha-BHC	x									
Aroclor-1232										x
Aroclor-1242										x
Benzene		**X**	x	X		x	x			X
Benzo(a)anthracene							x			
Benzo(a)pyrene							x			
Benzo(b)*fluoranthene*							x			
Bromomethane		X								
bis(2-Ethylhexyl)phthalate	x	X		X	x		X	X	X	X
Beta-BHC	x									
Carbon Disulfide					x					
Carbon Tetrachloride	**X**	**X**	X	**X**	X	**X**	**X**		X	X
Chlorobenzene		x				x				
Chloroform		**X**	x	X		X	x			
Chloromethane		**X**	X				X			
cis-1,3-Dichloropropene		x	X			X	x			
Dibromochloromethane		x	X							
Fluoranthene										
Hexachlorobutadiene		**X**	x	x						
Hexachloroethane		X								
Methylene Chloride	X	**X**	X	**X**	X	**X**	X	x		X
Pyrene										
Tetrachloroethene	**X**	**X**	**X**	**X**		**X**	**X**	X	X	X
Toluene										
trans-1,3-Dichloropropene		x	X	x						
Trichloroethene	**X**	**X**	**X**	**X**	X	**X**	**X**	X	X	X
Vinyl Chloride		X	X	x		x	X		X	X

228

The most probable sources were identified using the results of recent field sampling programs and process knowledge (RMRS, 1996b). A flow diagram (RMRS, 1996b) describes the method used to locate the contaminant plumes and corresponding sources, and to determine which areas should be targeted for remedial action. Other contaminants also will be addressed where there is an impact to surface water exceeding action levels.

There are six groundwater contaminant plumes identified where contaminant concentrations exceed 100 times the MCLs. These groundwater contaminant plumes include: 1) IHSS 119.1 Plume, 2) Mound Plume, 3) 903 Pad and Ryan's Pit Plume, 4) Carbon Tetrachloride Plume, 5) East Trenches Plume, and 6) Industrial Area Plume. In addition, there are three plumes with contaminant concentrations that do not exceed 100 times the MCLs, but that have the potential to impact surface water. These plumes are the Existing (Present) Landfill, Solar Ponds, and the Property Utilization and Disposal (PU&D) Yard Plumes (RMRS, 1996b).

D.2.1 Groundwater Contamination at 881 Hillside (OU1)

The 881 Hillside is located in the south-central portion of the Site on the north slope of Woman Creek as shown on Figure A-3. Figure D-1 presents detail of the IHSSs for OU1. The area was selected as a high priority site because of the elevated concentrations of VOCs detected in the alluvial groundwater, the relatively permeable soils, and the proximity to Woman Creek. The *Final Phase III RFI/RI Work Plan Revision 1, Rocky Flats Plant 881 Hillside Area OU1* (EG&G, 1991), outlines the activities that were required to identify the extent of contamination.

D.2.1.1 Individual Hazardous Substance Site 119.1 Plume

The drum storage area (IHSS 119.1) within OU1 is the site of historic releases of chlorinated VOCs to the environment. These releases have resulted in the contamination of shallow alluvial groundwater (i.e., the UHSU) and have formed a small, relatively stable contaminant plume extending down the 881 Hillside. Trichloroethylene (TCE), perchloroethylene (PCE), and 1,1,1 trichloroethane (TCA) are the most common organic contaminants at 881 Hillside.

In 1992, a French drain was installed to intercept contaminated groundwater perceived to be flowing down the 881 Hillside. The French drain is excavated as deep as 28 feet into bedrock and intercepts UHSU groundwater flowing in paleotopographic depressions. A three-foot diameter recovery well located within the source area also was installed to recover water containing high levels of dissolved VOCs.

The French drain is still in operation and is collecting relatively uncontaminated groundwater for treatment at the Building 891 Treatment Plant. The plume is upgradient of the French drain and does not appear to be migrating. The area immediately downgradient of the French drain is unsaturated, indicating that the French drain has dewatered much of the area. A small seep located south of IHSS 119.1 and downgradient of the French drain along Woman Creek was sampled once. This sample contained a trace amount of VOCs. However, it is not clear if the VOC concentrations in the seep water are related to the contaminant plume.

229

Groundwater in the unweathered bedrock at 881 Hillside did not appear to be impacted by contaminants transported by the alluvial groundwater system.

Information on groundwater quality for the French drain is documented in quarterly reports that have been produced as required in the French drain interim measures/interim remediation action (IM/IRA) (DOE, 1992a). Additional information on 881 Hillside is reported in the *OU1 Phase III RFI/RI Work Plan Revision 1* (EG&G, 1991) and in the *OU1 Final Phase III RFI/RI* (DOE, 1994a).

D.2.2 Groundwater Contamination Associated with the Former OU2

IHSSs grouped within the former OU2 are shown in Figure A-3. Figure D-2 presents details of the IHSSs for OU2. The 903 Pad is located in the southeast corner of the Site south of the inner east gate. The Mound is located north of Central Avenue at the southeast corner of the Protected Area. The East Trenches straddle the East Access Road, east of the inner east gate.

The 903 Pad and the Mound were historically used for the storage and burial, respectively, of radioactively contaminated wastes. Radioactively contaminated sludge and other materials were buried in the trenches (DOE, 1992b). The 903 Pad and Ryan's Pit Plume, Mound Plume, and East Trenches Plume are part of a large composite plume on the east side of the Site. Even though these contaminant plumes overlap, differing sources and flow paths make it effective to treat these parts of the large plume individually.

D.2.2.1 Mound Plume

The Mound site groundwater contaminant plume is poorly defined, but it is suspected to extend northward from the former location of the Mound where drums were buried to a point of discharge along South Walnut Creek, upstream of the Site Sewage Treatment Plant. Depending on the season, there may be many unsaturated areas within the plume. Dense nonaqueous phase liquids (DNAPLs) in the Mound area are suspected to be the source of the groundwater contamination and the potential exists for contaminant concentrations to increase over time. There is a possibility that Trench 1 could contribute to this plume; however, evidence indicates that the Mound site is the primary source.

Contaminated groundwater from the plume contains vinyl chloride, tetrachloroethene, and trichloroethene. The contaminant plume is discharging through surface and subsurface seepage into South Walnut Creek. The contaminated groundwater discharges at a rate of 0.5 gallons per minute (gal/min) or less at seep SW059, where it is collected and stored, then later treated at the Building 891 Treatment Plant

231

D.2.2.2 903 Pad and Ryan's Pit Plume

This contaminant plume has two, closely spaced sources: 1) VOCs associated with drums formerly stored at the 903 Storage Area, where the contents of the drums leaked into the subsurface and groundwater, and 2) Ryan's Pit where VOCs were disposed of in a trench. The contaminated groundwater flows southward from these two source areas, toward the South Interceptor Ditch and Woman Creek. The groundwater is contaminated with carbon tetrachloride, tetrachloroethene, trichloroethene, and other VOCs. The highest concentrations of VOCs in groundwater are near the 903 Pad and Ryan's Pit sources, although isolated areas of high concentration have been observed within the plume away from these sources. Pure-phase tetrachloroethene and motor fuel constituents were found during the excavation of Ryan's Pit. Pure-phase DNAPLs are also suspected to exist underneath the 903 Pad.

Groundwater flow paths in alluvial materials in the 903 Pad and Ryan's Pit area are relatively well defined by contact seeps with the underlying bedrock materials and by numerous wells. However, groundwater flow through the hillside colluvium and bedrock is poorly understood. Areas of unsaturated colluvium are fairly common and prediction of local flow paths is difficult. Depending on the season, there may be many unsaturated areas within the plume. Discharge of contaminated groundwater has not been observed from the colluvium or weathered bedrock portion of this plume.

Contaminated groundwater containing tetrachloroethene and trichloroethene may eventually enter the South Interceptor Ditch and Woman Creek surface water pathways if no actions are taken to manage this plume. Discharge of contaminated groundwater into Woman Creek would pose a potential risk to the environment. Collection and treatment of contaminated groundwater from the 903 Pad and Ryan's Pit Plume will reduce the risk to the environment posed by uncontrolled releases to surface water.

D.2.2.3 East Trenches Plume

A large plume of contaminated groundwater is located in the East Trenches area. The principal sources are IHSS 110 (Trench 3) and 111.1 (Trench 4), with a minor contribution from the VOCs in the 903 Pad area. The trenches were used to bury sewage sludge from the Sewage Treatment Plant, but also contain DNAPLs, crushed drums, and other miscellaneous waste. Contaminated groundwater occurs within the UHSU, in the alluvium, and in the bedrock sandstone that is in hydraulic connection with the alluvium. The major contaminants are carbon tetrachloride, tetrachloroethene, and trichloroethene, as well as other VOCs.

The downgradient boundary of the contaminant plume is located at a spring-and-seep complex on the south bank of South Walnut Creek above Ponds B1 and B2 where the bedrock sandstone subcrops. Concentrations of VOCs above 100 times the MCLs have been detected by a recent sampling program conducted at the seep complex. There are potential ecological impacts because water from the contaminant plume containing tetrachloroethene and trichloroethene has reached South Walnut Creek. If concentrations in the seep complex increase over time, a greater contaminant mass may reach surface water.

A lobe of this contaminant plume also extends to the east of the East Trenches area in the alluvium, but has not reached surface water. Uncontaminated alluvial groundwater discharges downgradient of this lobe as seeps in an unnamed tributary drainage to South Walnut Creek. This groundwater will continue to be monitored.

Additional background information on groundwater quality for OU2 is reported in *the Phase II RI/FS Work Plan, Rocky Flats Plant, 903 Pad, Mound, East Trenches Areas OU2* (Rockwell, 1989) and in the *Final Phase II RFI/RI OU2 Report* (DOE, 1995).

D.2.3 Solar Evaporation Ponds Groundwater Contamination (OU4)

The Solar Evaporation Ponds (SEPs)(IHSS 101) are located in the northeast section of the Protected Area as shown in Figure A-3. Figure D-3 presents details of the IHSS for OU4. The groundwater flow beneath the SEPs originates southwest of the Industrial Area and diverges flowing toward unsaturated areas above Walnut Creek and South Walnut Creek as shown on Plate 2.

The five ponds at IHSS 101 were used to temporarily store and treat various process aqueous wastes by evaporation. This included waste streams with low-level radioactivity, nitrates, acids, and sewage effluent. The configuration of these ponds has changed several times since they were initially installed in 1953. Previous hydrologic investigations of the SEP area indicated that the groundwater had been impacted by leakage from the ponds.

D.2.3.1 Solar Ponds Plume

Because contaminants were detected downgradient of the SEPs, a RCRA Assessment Groundwater Monitoring Program was instituted. Table D-1 lists contaminants detected in downgradient wells as reported in the annual RCRA groundwater monitoring reports (EG&G, 1992, 1993, 1994b, 1995; RMRS, 1996a). Groundwater monitoring data from UHSU wells indicate that nitrate contamination from the SEPs has migrated downgradient of the ITS in unconsolidated surficial deposits and weathered bedrock.

The released nitrates have contaminated UHSU groundwater and have formed a plume that extends northward from the SEPs to the North Walnut Creek drainage above Pond A1 (see Plate 3). A small lobe of this nitrate plume extends to the southwest for a short distance. This contaminant plume contains nitrates at concentrations above 100 times the MCLs. Nitrate concentrations within the plume are decreasing with time but still exist at high levels. The analytical data indicate that the maximum concentrations of all the contaminants occurred in the immediate area of the SEPs with concentrations declining rapidly downgradient.

In response to nitrate/nitrite contamination detected in Walnut Creek, a series of trenches and sumps were installed north of the SEPs from 1971 to 1974. The trenches and sumps were replaced by a more extensive interceptor trench system (ITS) in the early 1980s. The purpose of this ITS was to collect surface water and shallow groundwater immediately downgradient of the SEP area. Water collected by the ITS was originally transferred back to one of the SEPs (Advanced Sciences, 1991); but now the ITS water is pumped to the Building 374 treatment system. The ITS was replumbed in 1993 to increase its effectiveness. The ITS captures approximately 2.7 million gal of water per year but is not entirely effective in preventing nitrate contamination from impacting the North Walnut Creek drainage (DOE, 1994b)

Drainage of liquids and removal of sludge were completed at SEPs 207-A, 207-B North, 207-B Central, and 207-B South in 1994. The remaining pond, 207-C, has been drained and sludge has been removed to on-Site storage tanks.

The *Annual RCRA Groundwater Monitoring Reports for Regulated Units at the Site* contain available analytical data for the SEPs (EG&G, 1992, 1993, 1994a, 1995). Data are available for the second quarter 1988 through 1995. Additional information can be found in the *Draft IM/IRA Decision Document for OU4 Solar Evaporation Ponds* (EPA, 1994b) and the *OU4 Solar Evaporation Ponds Phase II Groundwater Investigation Final Field Program Report* (DOE, 1996a).

D.2.4 Industrial Area Groundwater Contamination

The Industrial Area has not received the same level of characterization as other portions of the Site. This is because the OUs associated with the Industrial Area had not completed RFI/RI investigations before the decision was made to integrate all remedial activities at the Site. Prior to the elimination of the OU-based investigations, OUs 8, 9, 10, 12, 13, and 14 were combined for purposes of remedial investigation. Preliminary surface soil investigations had been completed prior to cessation of activities on the Industrial Area OUs but no groundwater investigation had been started. However, two groundwater plumes have been generally defined; the Carbon Tetrachloride Plume and the Industrial Area Plume.

D.2.4.1 Carbon Tetrachloride Plume

Preliminary borehole drilling around tanks T9 and T10 in the former OU8 uncovered carbon tetrachloride free product that is associated with the Carbon Tetrachloride Plume. The carbon tetrachloride spill (IHSS 118.1) is located due north of Building 776 and east of Building 730. There are several documented past releases of carbon tetrachloride at this site. This area also overlaps other IHSSs [i.e., 121-T9, 121-T10, 131, and 144(N)]. Different spills are associated with these IHSSs.

236

IHSS 118.1 is the site where a 5,000-gal, underground steel storage tank for carbon tetrachloride and associated piping were formerly located. Numerous reported spills have occurred before 1970, some between 100 to 200 gal, as documented in the Historical Release Report (DOE, 1992b). The tank ultimately failed in June 1981 and subsequently was removed along with a limited amount of soil surrounding the tank. The numerous releases of carbon tetrachloride from IHSS 118.1 have contaminated surrounding soils and formed a contaminant plume in UHSU groundwater which extends from the vicinity of the former tank location eastward to the SEPs. The plume may eventually reach the Walnut Creek drainage.

D.2.4.2 Industrial Area Plume

The IM/IRA for the Industrial Area (DOE, 1994c) compiled groundwater and surface water data for use in designing a monitoring program for decontamination and decommissioning (D&D) activities. From these data, a groundwater plume composed of VOCs was discovered in groundwater in the Buildings 300 and 400 areas that later was defined as the Industrial Area Plume (see Plate 3). The Industrial Area Plume is suspected to be a coalesced plume of contaminated groundwater containing trichloroethene thought to emanate from IHSSs 117.1, 117.2, 157.1, 158, 171 and 182; tetrachloroethene thought to emanate from IHSSs 117.1, 117.2, 158, 157.1, 160, and 171; and carbon tetrachloride thought to emanate from IHSSs 117.1, 117.2, and 158.

Currently, the Industrial Area Plume does not appear to be migrating rapidly downgradient, and there are no known surface water impacts. However, groundwater pathways exist to both Woman Creek and to Walnut Creek. Groundwater recharge in the Industrial Area caused by water losses from sewers and water-supply pipelines may be substantial. Reduction of recharge from these sources could significantly reduce the potential for contaminant migration in the subsurface.

Treatment of contaminated groundwater within the Industrial Area does not appear to be necessary to protect surface water because the plume appears to have limited potential for migration. However, ongoing monitoring and evaluation of the groundwater through the monitoring program will continue and will detect any possible movement or expansion of the plume. Groundwater remedial actions may become necessary if the contaminant plumes expand and migrate significantly, thereby becoming a threat to surface water.

Further investigation of the plume or plumes in the Industrial Area has been suspended until D&D activities have been completed on buildings in the Industrial Area. Wells in the Industrial Area will be monitored for the known contaminants detected in the Industrial Area Plume.

D.2.5 Groundwater Contamination at the Existing Landfill (OU7)

The Existing (Present) Landfill began operation in 1968 with the closure of the Original Landfill (now IHSS 115). The Existing Landfill is located in the Buffer Zone north of the Protected Area as shown on Figure A-3. Figure D-4 presents detail of the IHSSs included in OU7. The local recharging groundwater flow direction is from the west-southwest toward the Existing Landfill, then is focused toward the Landfill Pond and the portion of the Walnut Creek drainage designated as "No Name Gulch" as shown on Plate 2.

In addition to typical sanitary landfill wastes, limited quantities of hazardous wastes were disposed of in the landfill, particularly in the early years of operation between 1968 and 1970. In September 1973, tritium was detected in leachate draining from the landfill. In response, a sampling program was initiated to determine the location of the tritium source and interim response measures were also undertaken to control the generation and migration of landfill leachate. Interim response measures included the construction of two ponds, of which the East Landfill Pond remains, and a subsurface leachate collection system and a subsurface intercept/slurry wall system for diverting upgradient groundwater.

Evaluation of groundwater quality data (EG&G, 1994) specifically within the Existing Landfill revealed elevated radionuclide activities and high concentrations of VOCs, metals, and inorganic constituents. The Existing Landfill has been under a RCRA Alternate Groundwater Monitoring Program. Table D-1 lists the chemicals detected in the Existing Landfill based on data generated from the groundwater monitoring program. Aluminum, manganese, zinc, 2-methylnaphthalene, naphthalene, benzene, and possibly methylene chloride are present in leachate below the current landfill, with average values exceeding action levels. Organic contaminant plumes exist in groundwater south and west of the current landfill pond, including a portion of OU7. Groundwater in downgradient wells below the landfill pond show elevated concentrations of nitrate, sulfate, chloride, lithium, barium, strontium, magnesium, and uranium with respect to upgradient wells (RMRS, 1996a).

D.2.5.1 PU&D Yard Plume

In 1993, newly installed upgradient wells at the Process Simulation Laboratory (PSL) detected significant concentrations of VOCs in the alluvial groundwater. These data and data from wells on the south side of the PSL suggest that a VOC plume exists upgradient of the PSL and has migrated eastward (see Plate 3). The suspected source of the contamination is the PU&D yard located west of the landfill. Activities are being planned to evaluate the source of this plume.

Additional information on water quality at the PSL can be found in the *Annual RCRA Groundwater Monitoring Reports For Regulated Units* (EG&G, 1992, 1993, 1994a, 1995; RMRS, 1996a), *Technical Memorandum - Final Work Plan for OU7* (DOE, 1994d) and *Draft IM\IRA Decision Document for OU7 Present Landfill* (DOE, 1996b).

238

D.2.6 Old Landfill (OU5)

The Old Landfill (OLF) is geographically located along the north side of Woman Creek and is designated as IHSS 115. The OLF was investigated as part of the OU5 RFI/RI project (DOE, 1996c). Figure A-3 shows the IHSSs covered in OU5.

Elevated concentrations of a few metals, water quality parameters, radionuclides and VOCs were encountered in wells monitoring the OLF (see Table D-1). TCE and TCA were the only volatile organics encountered. Though contamination from the OLF is at low levels, and a downgradient contaminant plume has not been defined, the proximity of the IHSS to Woman Creek has made it a priority for monitoring

D.3 References

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240

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APPENDIX E

Water Quality and Water Level Monitoring Wells

List of Tables

243

APPENDIX E-1
PROPOSED MONITORING WELLS

WELL NO	FREQUENCY	CLASS	PLUME\AREA	DRIVERS	FORMATION	PURPOSE	
5387	Semiannual	PE	881 Hillside	RFCA	AL	Plume Extent south of the 881Hillside Plume	
4887	Semiannual	PE	881 Hillside	RFCA	AL	Plume Extent south of the 881 Hillside Plume	
4787	Semiannual	PE	881 Hillside	RFCA	AL	Plume Extent south of the 881 Hillside Plume	
00797	Semiannual	PM	881 Hillside	RFCA	AL	Performance Monitoring for 881 Footing Drain Sump	
11092	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain	
10992	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain	
10792	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain	
10692	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain	
10592	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain	
0487	Semiannual	PD	881 Hillside	RFCA	AL	Plume Definition well for the 881 Hillside Plume	
891COLGAL	Quarterly	PM	881 Hillside	RFCA/IMIRA -FD	NA	Performance Monitoring of groundwater in collection sump in French Drain	
891COLWEL	Quarterly	PM	881 Hillside	RFCA/IMIRA -FD	AL	Performance Monitoring of groundwater in collection well on 881 Hillside	
SW13494	Quarterly	PM	881 Hillside	RFCA/IMIRA -FD	NA	Performance Monitoring of groundwater in footing drain seep below Bldg. 881	
6386	Semiannual	PD	903 Pad	RFCA	AL	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume	
6286	Semiannual	PD	903 Pad	RFCA	BD/USHU	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume	
3087	Semiannual	PD	903 Pad	RFCA	BD	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume	
2987	Semiannual	PD	903 Pad	RFCA	AL	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume	
23196	Semiannual	PE	903 Pad	RFCA	AL	Plume Extent well monitoring the southward migration of the Ryans Pit/903 Pad Plume	
23096	Semiannual	PE	903 Pad	RFCA	AL	Plume Extent well monitoring the southern migration of the Ryans- OU2 VOA Plume	
07391	Semiannual	PM	903 Pad	RFCA	AL\BD	Performance Monitoring well monitoring effects of remediation downgradient of Ryans Pit	
00491	Semiannual	PD	903 Pad	RFCA	BD\UHSU	Plume Definition well monitoring the 903 Pad VOC Plume	
02297	Semiannual	DD	Bldg 779	RFCA, IM/IRA for IA	AL	D&D monitoring downgradient of Bldg. 779	
02497	Semiannual	DD	Bldg 779	RFCA, IM/IRA for IA	AL	D&D monitoring downgradient of Bldg. 779	
02397	Semiannual	DD	Bldg 779	RFCA, IM/IRA for IA	AL	D&D monitoring upgradient of Bldg. 779	
22996	Semiannual	DD	Bldg 886	RFCA, IM/IRA for IA	AL	Building D&D well monitoring potential rad contamination near 886 lab	
10198	Semiannual	DD	Bldg. 123	RFCA -IM/IRA	AL	D & D Monitoring for Building 123 D&D	
10298	Semiannual	DD	Bldg. 123	RFCA -IM/IRA	AL	D & D Monitoring for Building 123 D&D	
10398	Semiannual	DD	Bldg. 123	RFCA -IM/IRA	AL	D & D Monitoring for Building 123 D&D	
10498	Semiannual	DD	Bldg. 123	RFCA -IM/IRA	AL	D & D Monitoring for Building 123 D&D	
10598	Semiannual	DD	Bldg. 123	RFCA -IM/IRA	AL	D & D Monitoring for Building 123 D&D	
41691	Semiannual	B	Boundary	RFCA, AIP	AL	Boundary Well - in the Walnut Cr. Drainage at the Indiana Street Boundary	
41591	Semiannual	B	Boundary	RFCA, AIP	AL	Boundary Well - in small drainage near east access gate	
10394	Semiannual	B	Boundary	RFCA, AIP	AL	Boundary Well - in the Woman Cr. Drainage at the Indiana Street Boundary	
10294	Semiannual	B	Boundary	RFCA, AIP	AL	Boundary Well - in drainage below Pond D-2 in the southeast corner of the Site	
06491	Semiannual	B	Boundary	RFCA, AIP	BD/UHSU	Boundary Well - in small drainage east of the Site at Indiana St.	
0386	Semiannual	B	Boundary	RFCA, AIP	BD/UHSU	Boundary Well - in small drainage north of the east access gate	
P219189	Semiannual	PD	Carbon Tet	RFCA, RCRA	AL	Plume Definition well for VOC contamination comming from Carbon Tet Plume	
P209389	Semiannual	PD	Carbon Tet	RFCA, RCRA	BD	Plume Definition well in the Carbon Tet Plume	
P209289	Semiannual	PD	Carbon Tet	RFCA, RCRA	AL	Plume Definition well in the Carbon Tet Plume	
12191	Semiannual	PM	East Tranches	RFCA	BD\UHSU	Performance Monitoring at edge of T3 soil excavation	
23296	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the northern migration of the East Trenches Area Plume	
10194	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the southern migration of the East Trenches Plume	
06091	Semiannual	PE	East Trenches	RFCA	AL/BD	Plume Extent well monitoring the northeast migration of the East Trenches Plume	
05091	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the eastward migration of the East Trenches Plume	
04991	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the eastward migration of the East Trenches Plume	
04591	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the southward migration of the East Trenches Plume	
04091	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the northward migration of the East Trenches Plume	
03991	Semiannual	PD	East Trenches	RFCA	AL	Plume Definition well monitoring the East Trenches Plume	
11891	Semiannual	PM	East Trenches	RFCA	BD\UHSU	Performance Montoring well monitoring effects of remediation downgradient of Trench T-3	
3687	Semiannual	PM	East Trenches	RFCA	BD\USHU	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-4	
12691	Semiannual	PM	East Trenches	RFCA	BD\USHU	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-4	
05691	Semiannual	PM	East Trenches	RFCA	AL	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-4	
05391	Semiannual	PD	East Trenches	RFCA	AL	Plume Definition well monitoring eastward concentration of VOCs from the East Trenches Plume	
10994	Semiannual	PE	IA\Old Landfill	RFCA	AL	Plume Extent IA VOA Plume\Old Landfill Plume near Woman Cr.	
7086	Semiannual	PE	IA\Old Landfill	RFCA	AL	Plume Extent well monitoring IA Plume and Old Landfill Plume pathway in Woman Cr.	
P416889	Semiannual	PD	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Definition of IA Plume south of Bldg. 664 along pathway to Woman Cr.	
P416789	Semiannual	PD	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Definition of IA Plume south of 400 area along pathway to Woman Cr.	

2444

APPENDIX E-1
PROPOSED MONITORING WELLS

P416689	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent to monitor southern migration of IA Plume south of Bldg. 440	
P314289	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent to monitor the southern migration of IA Plume near Bldg. 850	
P313589	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent to monitor the eastward migration of IA Plume near Bldg. 881	
P114389	Semiannual	PE	Ind. Area	RFCA	AL	Plume Extent well to monitor extent of PU&D yard plume pathway to Walnut Cr.	
6186	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring easward migration of IA Plume	
43392	Semiannual	PE	Ind. Area	RFCA	AL	Plume Extent well monitoring southward migration of IA Plume	
22896	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring the northward migration of IA VOA Plume	
22796	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring the northward migration of Carbon Tet Plume	
22696	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring the westward migration of the Carbon Tet Plume	
22596	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring the northern migration of the IA Plume	
2186	Semiannual	PE	Ind. Area	RFCA	BD/UHSU	Plume Extent well monitoring the northern migration of the 'IA Plume	
1986	Semiannual	PE	Ind. Area	RFCA	AL	Plume Extent well monitoring the northern migration of the IA PLume	
B206989	Quarterly	RCRA	Landfill	RFCA, RCRA	BD/UHSU	RCRA\Plume Extent well monitoring downgradient of Landfill Plume	
77392	Semiannual	PD	Landfill	RFCA, RCRA	AL	Plume Definition well monitoring the eastward migration of the PU&D Yard Plume	
52994	Quarterly	RCRA	Landfill	RFCA, RCRA	AL	RCRA/Plume Extent well monitoring downgradient of Landfill Plume	
52894	Quarterly	RCRA	Landfill	RFCA, RCRA	AL	RCRA/Plume Extent well monitoring downgradient of Landfill Plume	
4087	Quarterly	RCRA	Landfill	RFCA, RCRA	AL	RCRA/Plume Extent well monitoring downgradient of Landfill Plume	
02291	Semiannual	PM	Mound	RFCA	BD/UHSU	Performance Monitoring on the Mound Source remediation	
00897	Semiannual	PM	Mound	RFCA	BD/UHSU	Performance Monitoring on the Mound Source remediation	
3586	Semiannual	PE	Mound	RFCA	AL	Plume Extent well tracking migration of Solar Ponds nitrate Plume	
15599	Quarterly	PM	Mound	RFCA	AL	Performance Monitoring for the Mound groundwater treatment system	
15699	Quarterly	PM	Mound	RFCA	AL	Performance Monitoring for the Mound groundwater treatment system	
15799	Quarterly	PM	Mound	RFCA	AL	Performance Monitoring for the Mound groundwater treatment system	
75992	Semiannual	PE	Mound\E. Trench	RFCA	AL	Plume Extent well monitoring So. Walnut Cr. Drainage below Mound Site Plume	
08091	Semiannual	PE	Mound\E. Trench	RFCA	AL	Plume Extent well monitoring the southern migration of Mound and East Trenches Plumes	
6486	Semiannual	D	NA	RFCA	AL	Drainage well monitoring the Woman Cr. drainage downgradient of the 881 Hillside Plume	
5587	Semiannual	D	NA	RFCA	AL	Drainage well monitoring the Woman Cr. drainage south of the 881 Hillside Plume	
38591	Semiannual	D	NA	RFCA	AL	Drainage well in Woman Cr. Drainage below 881 Hillside Plume	
6586	Semiannual	D	NA	RFCA	AL	Drainage well monitoring the No. side Woman Cr. below 903Pad/Ryans Pit Plume	
00997	Semiannual	D	NA	RFCA	AL	Drainage Well - below Pond B-4 in South Walnut Creek Drainage	
1386	Semiannual	D	NA	RFCA	AL	Plume Definition well monitoring the migration of the SEP Nitrate and Carbon Tet Plumes	
00197	Semiannual	PE	Old Landfill	RFCA	AL	Plume Extent well monitoring the Industrial Area Plume	
00397	Semiannual	PE	PU&D	RFCA	AL	Plume Extent well monitoring the PU&D Yard Plume	
02197	Semiannual	PE	PU&D	RFCA	AL	Plume Extent well monitoring the PU&D Yard Plume	
70493	Quarterly	RCRA	PU&D	RFCA, RCRA	BD/UHSU	RCRA upgradient/Plume Definition well monitoring the edge of the PU&D Yard Plume	
70393	Quarterly	RCRA	PU&D	RFCA, RCRA	AL	RCRA upgradient /Plume Definition well monitoring the edge of the PU&D Yard Plume	
70193	Quarterly	RCRA	PU&D	RFCA, RCRA	BD/UHSU	RCRA upgradient/Plume Extent well monitoring the PU&D Yard Plume	
5887	Quarterly	RCRA	PU&D	RFCA, RCRA	AL	RCRA upgradient/ Plume Extent Well monioring the PU&D Yard Plume - LF	
76992	Semiannual	PE	PU&D\Landfill	RFCA, RCRA	AL	Plume Extent well monitoring the eastward migration of the PU&D Yard/Landfill Plume	
00597	Semiannual	PD	PU&D\Landfill	RFCA, RCRA	AL	Plume Definition well monitoring the Landfill/PU&D yard Plume	
00297	Semiannual	PD	Solar Ponds	RFCA	AL	Plume Definition well monitoring the southern migration of the Solar Ponds Plume	
P219489	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Extent well monitoring the northern migration of the SEP Nitrate Plume	
P218389	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Extent well monitoring the northern migration of the SEP Nitrate Plume	
B208289	Semiannual	PE	Solar Ponds	RFCA	BD/UHSU	Plume Extent well monitoring the northeast mitgration of the SEP Nitrate Plume	
3386	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Extent well monitoring the southern migration of the SEP Nitrate and Carbon Tet Plumes	
1786	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Definition well monitoring the migration of the SEP Nitrate and Carbon Tet Plumes	
B208789	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Extent well monitoring the northeast mitgration of the SEP Nitrate Plume	
P209489	Semiannual	PD	Solar Ponds	RFCA	BD\UHSU	Plume Definition well for the Carbon Tet. Plume	
18199	Semiannual	PA	IHSS 118.1	AL	AL	Plume Degredation well monitoring the IHSS 118.1 plume	
18299	Semiannual	PA	IHSS 118.1	AL	AL	Plume Degredation well monitoring the IHSS 118.1 plume	
18399	Semiannual	PA	IHSS 118.1	AL	AL	Plume Degredation well monitoring the IHSS 118.1 plume	
18499	Semiannual	PA	IHSS 118.1	AL	AL	Plume Degredation well monitoring the IHSS 118.1 plume	
18599	Semiannual	PA	IHSS 118.1	AL	AL	Plume Degredation well monitoring the IHSS 118.1 plume	
18699	Semiannual	PA	IHSS 118.1	AL	AL	Plume Degredation well monitoring the IHSS 118.1 plume	
18799	Semiannual	PA	IHSS 118.1	AL	AL	Plume Degredation well monitoring the IHSS 118.1 plume	
18899	Semiannual	PA	IHSS 118.1	AL	AL	Plume Degredation well monitoring the IHSS 118.1 plume	

345

APPENDIX E
PROPOSED MONITORING WELLS CHEMICALS TO BE MONITORED

WELLNO	FREQUENCY	PLUME\AREA	VOC Suite	METALS Suite	TRITIUM	PU/AM	SR 89/90	URANIUM	NITRATE	FLUORIDE	SULPHATE	CYANIDE	CESIUM	CHLORIDE	SULFIDE	DOC/TOC	METHANE
891COLWEL	Quarterly	881 Hillside	X	X				X									
SW13494	Quarterly	881 Hillside	X	X				X									
5387	Semiannual	881 Hillside	X	X				X	X		X						
4887	Semiannual	881 Hillside	X	X				X	X		X						
4787	Semiannual	881 Hillside	X	X				X	X		X						
00797	Semiannual	881 Hillside	X	X				X	X		X						
11092	Semiannual	881 Hillside	X	X				X	X		X						
10992	Semiannual	881 Hillside	X	X				X	X		X						
10792	Semiannual	881 Hillside	X	X				X	X		X						
10692	Semiannual	881 Hillside	X	X				X	X		X						
10592	Semiannual	881 Hillside	X	X				X	X		X						
0487	Semiannual	881 Hillside	X	X				X	X		X						
891COLGAL	Quarterly	881 Hillside	X	X				X									
6386	Semiannual	903 Pad	X	X		X		X	X		X						
6286	Semiannual	903 Pad	X	X		X		X	X		X						
3087	Semiannual	903 Pad	X	X		X		X	X		X						
2987	Semiannual	903 Pad	X	X		X		X	X		X						
23196	Semiannual	903 Pad	X	X		X		X	X		X						
23096	Semiannual	903 Pad	X	X		X		X	X		X						
07391	Semiannual	903 Pad	X	X		X		X	X		X						
00491	Semiannual	903 Pad	X	X		X		X	X		X						
02297	Semiannual	Bldg 779	X	X		X		X	X								
02497	Semiannual	Bldg 779	X	X		X		X	X								
02397	Semiannual	Bldg 779	X	X		X		X	X								
22996	Semiannual	Bldg 886	X	X		X	X	X									
10198	Semiannual	Bldg. 123	X	X		X		X	X			X	X				
10298	Semiannual	Bldg. 123	X	X		X		X	X			X	X				
10398	Semiannual	Bldg. 123	X	X		X		X	X			X	X				
10498	Semiannual	Bldg. 123	X	X		X		X	X			X	X				
10598	Semiannual	Bldg. 123	X	X		X		X	X			X	X				
41691	Semiannual	Boundary	X	X	X	X	X	X	X	X	X						
41591	Semiannual	Boundary	X	X	X	X		X	X	X	X						
10394	Semiannual	Boundary	X	X	X	X	X	X	X	X	X						
10294	Semiannual	Boundary	X	X	X	X		X	X	X	X						
06491	Semiannual	Boundary	X	X	X	X		X	X	X	X						
0386	Semiannual	Boundary	X	X	X	X		X	X	X	X						
P219189	Semiannual	Carbon Tet	X	X	X	X	X	X	X	X	X						
P209389	Semiannual	Carbon Tet	X	X	X	X	X	X	X	X	X						
P209289	Semiannual	Carbon Tet	X	X	X	X	X	X	X	X	X						
1386	Semiannual	Drainage	X	X	X	X	X	X	X	X	X						
6486	Semiannual	Drainage	X	X			X	X	X		X						
5587	Semiannual	Drainage	X	X			X	X	X		X						
38591	Semiannual	Drainage	X	X			X	X	X		X						
6586	Semiannual	Drainage	X	X		X		X	X								
00997	Semiannual	Drainage	X	X		X	X	X									
23296	Semiannual	East Trenches	X	X		X		X	X								
10194	Semiannual	East Trenches	X	X		X		X	X								
06091	Semiannual	East Trenches	X	X		X		X	X								
05091	Semiannual	East Trenches	X	X		X		X	X								
04991	Semiannual	East Trenches	X	X		X		X	X								
04591	Semiannual	East Trenches	X	X		X		X	X								
04091	Semiannual	East Trenches	X	X		X		X	X								
03991	Semiannual	East Trenches	X	X		X		X	X								
11891	Semiannual	East Trenches	X	X		X		X	X								
3687	Semiannual	East Trenches	X	X		X		X	X								
12691	Semiannual	East Trenches	X	X		X		X	X								
05691	Semiannual	East Trenches	X	X		X		X	X								

246

APPENDIX E
PROPOSED MONITORING WELLS CHEMICALS TO BE MONITORED

WELLNO	FREQUENCY	PLUME\AREA	VOC Suite	METALS Suite	TRITIUM	PU/AM	SR 89/90	URANIUM	NITRATE	FLUORIDE	SULPHATE	CYANIDE	CESIUM	CHLORIDE	SULFIDE	DOC/TOC	METHANE
05391	Semiannual	East Trenches	X	X		X		X	X								
12191	Semiannual	East Trenches	X	X		X		X	X								
10994	Semiannual	IA\Old Landfill	X	X			X	X	X		X						
7086	Semiannual	IA\Old Landfill	X	X			X	X	X		X						
P416889	Semiannual	Ind. Area	X	X		X		X	X								
P416789	Semiannual	Ind. Area	X	X		X		X	X								
P416689	Semiannual	Ind. Area	X	X		X		X	X								
P314289	Semiannual	Ind. Area	X	X		X		X	X								
P313589	Semiannual	Ind. Area	X	X		X		X	X								
P114389	Semiannual	Ind. Area	X	X		X		X	X								
6186	Semiannual	Ind. Area	X	X		X		X	X								
43392	Semiannual	Ind. Area	X	X		X		X	X								
22896	Semiannual	Ind. Area	X	X		X		X	X								
22796	Semiannual	Ind. Area	X	X		X		X	X								
22696	Semiannual	Ind. Area	X	X		X		X	X								
22596	Semiannual	Ind. Area	X	X		X		X	X								
2186	Semiannual	Ind. Area	X	X		X		X	X								
1986	Semiannual	Ind. Area	X	X		X		X	X								
B206989	Quarterly	Landfill	X	X	X			X	X	X	X						
77392	Semiannual	Landfill	X	X	X			X	X	X	X						
52994	Quarterly	Landfill	X	X	X			X	X	X	X						
52894	Quarterly	Landfill	X	X	X			X	X	X	X						
4087	Quarterly	Landfill	X	X	X			X	X	X	X						
02291	Semiannual	Mound	X	X		X		X	X								
00897	Semiannual	Mound	X	X		X		X	X								
3586	Semiannual	Mound	X	X		X		X	X								
15599	Quarterly	Mound	X			X		X									
15699	Quarterly	Mound	X			X		X									
15799	Quarterly	Mound	X			X		X									
75992	Semiannual	Mound\E. Trench	X	X		X	X	X	X								
08091	Semiannual	Mound\E. Trench	X	X		X	X	X	X								
00197	Semiannual	Old Landfill	X	X	X		X	X	X	X	X						
00397	Semiannual	PU&D	X	X	X			X	X	X	X						
02197	Semiannual	PU&D	X	X	X			X	X	X	X						
70493	Quarterly	PU&D	X	X	X			X	X	X	X						
70393	Quarterly	PU&D	X	X	X			X	X	X	X						
70193	Quarterly	PU&D	X	X	X			X	X	X	X						
5887	Quarterly	PU&D	X	X	X			X	X	X	X						
76992	Semiannual	PU&D\Landfill	X	X	X			X	X	X	X						
00597	Semiannual	PU&D\Landfill	X	X	X			X	X	X	X						
00297	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X						
P219489	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X						
P218389	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X						
B208289	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X						
3386	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X						
1786	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X						
B208789	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X						
P209489	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X						
18199	Semiannual	IHSS 118.1	X						X		X			X	X	X	X
18299	Semiannual	IHSS 118.1	X						X		X			X	X	X	X
18399	Semiannual	IHSS 118.1	X						X		X			X	X	X	X
18499	Semiannual	IHSS 118.1	X						X		X			X	X	X	X
18599	Semiannual	IHSS 118.1	X						X		X			X	X	X	X
18699	Semiannual	IHSS 118.1	X						X		X			X	X	X	X
18799	Semiannual	IHSS 118.1	X						X		X			X	X	X	X
18899	Semiannual	IHSS 118.1	X						X		X			X	X	X	X

247

Appendix E-3 Water Level Monitoring Wells

WELL	SITE-WIDE[1]		
	WATER QUALITY	INDUSTRIAL AREA	BACKGROUND
Alluvium			
0186		730	
1086		730	
1386	12		
1786	12		
1886		2	
1986	12		
2286		12	
2486		2	
2686		2	
2986		2	
3386	12		
3586	12		
3686		2190	
3986		730	
4286		12	
4386		12	
4486		2	
4786			730
5586			730
5686			12
6186	4		
6386	4		
6486	12		
6586	12		
6686		12	
6786			2
6886		2190	
7086	4		
0187		730	
0487	12		
1087		2	
1487		730	
1587		730	
1987		2	
2187		2	
2487		2	
2687		2	
2987	4		
3287		2	
3387		2	
4087	12		
4287		730	
4387		2	
4787	4		
4887	4		
5287		12	

248

Appendix E-3 Water Level Monitoring Wells

WELL	SITE-WIDE[1] WATER QUALITY	INDUSTRIAL AREA	BACKGROUND
5387	4		
5587	12		
5887	4		
6087		2	
7187		2	
B400389			12
B200589			730
B200889			730
B102289			2
B102389			2
B402689			12
P207689		2	
P207889		2	
B208089		12	
B208789	4		
P209289	4		
P209789		2	
P209889		730	
B210489		2190	
B410589			12
B410689			2
B410789		2	
B110889		2	
B110989			12
B111189			12
B411289			12
P313489		2	
P313589	12		
P213689		730	
P414189		730	
P314289	12		
P114389	12		
P114489		2	
P114689		2	
P114789		2	
P114889		730	
P114989		2	
P115089		12	
P115489		730	
P115589		2	
P115689		2	
P215789		2	
P415889		730	
P415989		2	
P416089		12	
P416189		2	
P416289		2	

249

Appendix E-3 Water Level Monitoring Wells

WELL	SITE-WIDE[1] WATER QUALITY	INDUSTRIAL AREA	BACKGROUND
P416389		2	
P416489		12	
P416589		730	
P416689	12		
P416789	12		
P416889	12		
P317989		2	
P218089		2	
P218289		2	
P218389	12		
P219189	12		
P119389		730	
P219489	4		
P320089		2	
0190			12
0290			12
0390			12
0990			12
1190			730
1290			2
1390			2
1490			12
00191		2	
00491	4		
01291		2	
01391		12	
03191		2	
03991	4		
04091	4		
04191		2	
04591	4		
04991	4		
05091	4		
05191		730	
05291		2	
05391	4		
05691	4		
06191		2	
06991		2	
07291		12	
07391	4		
08091	4		
13091		2	
13391		2	
13491		2	
13591		2	
20291		12	

250

Appendix E-3 Water Level Monitoring Wells

	SITE-WIDE[1]		
WELL	WATER QUALITY	INDUSTRIAL AREA	BACKGROUND
20691		730	
34791		2	
37191		2	
37591		730	
37691		2	
37791		2	
38591	4		
41091		12	
41591	12		
41691	12		
10592	4		
10692	4		
10992	4		
11092	4		
43392	4		
46292			2
46492		2	
75292		12	
75992	4		
76792		2	
76992	4		
77392	4		
77492		730	
00293			12
05193		12	
05293		730	
45793		2	
58793		2	
59493		2	
59893		2	
60693		2	
61293		2	
62593			12
62693			12
62893		2	
70393	4		
70693		2	
10194	4		
10294	4		
10394	4		
10594		2	
10694		2	
10794		2190	
10994	4		
11294			12
11494			730
11594			12

Appendix E-3 Water Level Monitoring Wells

WELL	SITE-WIDE[1] WATER QUALITY	INDUSTRIAL AREA	BACKGROUND
50494			2
50694		2	
51094			2
51194		2	
51294		12	
51494			730
51594			12
52894	4		
52994	4		
56994		2	
57094		2	
59594		2	
60294		2	
60994		2	
60195		12	
60295		2	
60395		2	
60695		2	
60795		2	
61295		2	
61495		2	
61595		2	
61695		2	
62395			12
63395		2	
63495		2	
63795			12
63895			12
20196			2
20296			2
20396			2
20496			2
20596			2
20696			12
20796			2
22596	12		
22696	4		
22796	4		
22896	4		
22996	12		
23096	4		
23196	4		
23296	4		
00197	4		
00297	4		
00397	4		
00697	4		

252

Appendix E-3 Water Level Monitoring Wells

WELL	SITE-WIDE[1] WATER QUALITY	INDUSTRIAL AREA	BACKGROUND
00597	4		
00797	4		
00897	4		
00997	12		
02197	4		
02297	4		
02397	4		
02497	4		
10098	12		
10198	4		
10298	4		
10398	4		
10498	4		
10598	4		
15199	4		
15299	4		
15399	4		
15499	4		
15599	4		
15699	4		
15799	4		
18199	4		
18299	4		
18399	4		
18499	4		
18599	4		
18699	4		
18799	4		
18899	4		
P419689		2	
06091	12		
10894		2	
Bedrock			
0386	12		
2186	4		
6286	4		
3087	4		
3687	4		
B206989	4		
B208289	4		
P209389	4		
P209489	4		
P114589		2	
P416989		2	
03791		730	
06291		12	

253

Appendix E-3 Water Level Monitoring Wells

	SITE-WIDE[1]		
WELL	WATER QUALITY	INDUSTRIAL AREA	BACKGROUND
06491	4		
11891	4		
12191	4		
12691	4		
20991		730	
10792	4		
70193	4		
70493	4		
	668	25204	5404

Note:
Numbers in columns denote measurement frequency per year

254

Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

Air Monitoring

September 1999

255

Table of Contents

4.0 AIR MONITORING

4.1 Introduction

Regulatory activities encompassed by federal and state regulations established pursuant to the Clean Air Act (CAA) and its amendments are managed and directed at the Rocky Flats Environmental Technology Site (RFETS or Site) by the Air Quality Management (AQM) group within Kaiser-Hill Company's (Kaiser-Hill) Environmental Systems and Stewardship (ESS) organization. AQM is responsible for developing compliance, reporting, and recordkeeping strategies that organizations on Site use to maintain compliance with applicable air quality regulations and Department of Energy (DOE) Orders. Within that framework, AQM operates effluent, ambient, and meteorological monitoring programs that support both compliance demonstration and emergency response needs at the Site. Additional air monitoring is performed by the Colorado Department of Public Health and Environment (CDPHE) or coordinated by DOE.

The goal of the Site air quality program is to provide a means to assess the impact of Site operations on air quality, on and around the Site, and thereby protect the public and the environment. These monitoring programs contribute to the Site-wide environmental protection program by providing data that can be used to quantify and/or characterize the air pathway impact on public receptors.

4.1.1 Air Monitoring Objectives and Regulatory Drivers

Air monitoring programs, on and around the Site, fulfill multiple objectives. In many cases, those objectives are mandated by CAA regulations or by DOE Orders. Regulatory drivers pertinent to air monitoring programs include:

- Effluent Monitoring:
  - Title 40 of the *Code of Federal Regulations (CFR),* Part 61, Subpart A "General Provisions," Subpart H "National Emission Standards for the Emissions of Radionuclides Other Than Radon From DOE Facilities" [Rad NESHAPs]), and Appendix B,
  - Colorado Air Quality Control Commission (CAQCC) Regulation No. 8, Part A, Subpart A, "General Provisions", Subpart C, "National Emission Standard for Beryllium," and Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities," and
  - DOE Order 5400.1, *General Environmental Protection Program*, U.S. Department of Energy.

558

- Ambient Monitoring:
  - DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy (Ch 1.10), and
  - 40 CFR 61, Subpart H and CAQCC Regulation No. 8, Part A, Subpart H (ambient monitoring performed as alternative compliance demonstration method).

- Meteorological Monitoring:
  - 40 CFR 61, Subpart H and CAQCC Regulation No. 8, Part A, Subpart H (meteorological observables used as input to compliance dispersion modeling),
  - DOE Order 5400.1-IV; 2.4, *General Environmental Protection Program*, U.S. Department of Energy, and
  - DOE Order 5500.3A, *Emergency Planning and Preparedness for Operational Emergencies,* U.S. Department of Energy.

Air monitoring is performed to comply with regulatory requirements and to support the assessment of Site operations, either directly, as is the case with the effluent monitoring program, or indirectly, as with ambient and meteorological monitoring. For example, while monitoring of radioactive emissions from building process vents fulfills monitoring and reporting requirements of both DOE Orders and Rad NESHAP regulations, these effluent data also support Nuclear Safety evaluations of the building safety envelope.

Effluent monitoring also supports as-low-as-reasonably-achievable (ALARA) principals. These DOE principals provide a conceptual radiation exposure guideline intended to encourage radiation protection practices that are more protective than those of any prescribed standard. The basis for this concept is the acknowledgment that low exposure dose-effect relationships may exist that cannot be measured or demonstrated scientifically. Effluent monitoring is used to verify the efficacy of radiation control mechanisms that are used in the areas containing and handling significant quantities of radionuclide materials. Levels of emissions that cause no concern from an environmental regulatory perspective are sufficient to trigger a proactive investigative response under the ALARA concept.

Ambient monitoring of radionuclides on the Site and at the perimeter is performed by AQM and by CDPHE. Ambient monitoring in the communities immediately adjacent to the Site is coordinated by DOE, as explained below.

Ambient monitoring satisfies DOE Order requirements and has recently been given tentative approval for use in satisfying Rad NESHAP compliance demonstration requirements. Ambient data can be used in human health risk assessment evaluations of Operable Unit closure. Data from ambient monitoring are also used to validate projections made by dispersion modeling. In addition, ambient data from the Site's Radioactive Ambient Air Monitoring Program (RAAMP) are used to confirm that controls are operating within Nuclear Safety's ALARA limits, under the DOE directive that strives to keep dose to all receptors as low as reasonably possible by maintaining administrative and physical controls on all potential sources of radiological exposure.

On-Site meteorological monitoring supports both the Rad NESHAP reporting requirements and emergency response requirements under the DOE Orders. Meteorological data are currently used for air quality monitoring support, atmospheric dispersion modeling, hydrological studies, construction management, and safety investigations. Emergency response operations and their associated modeling efforts make major use of the on-Site meteorological data.

In cooperation with the surrounding communities, DOE has implemented a five-station Community Radiation (ComRad) Monitoring Program. Independently operated monitoring stations were installed in 1992 in the communities of Arvada, Westminster, Broomfield, and Northglenn. Ambient concentrations of plutonium (Pu), meteorological data, and gamma radiation data are collected continuously using monitoring protocols comparable to those at the Site. Sample analysis is performed by U.S. Environmental Protection Agency (EPA) Region VII laboratories in Las Vegas. Although not a compliance-driven monitoring program, DOE supports this independent evaluation of its potential emissions as a gesture of public assurance of the Site's safe operation.

4.1.2 Site Air Monitoring Scope

The AQM organization provides programmatic support to Site operations to assure compliance with all state and federal laws and regulations originating from the CAA and its amendments, and DOE Orders related to the air impacts of Site operations. The scope of this support includes the characterization of both airborne materials and the meteorology responsible for their transport and dispersion, with monitoring activities playing a major role in this characterization. Criteria for success include completeness of permitting and surveillance activities, no violations of air quality regulations, adequate quality assurance/quality control (QA/QC) of the measurement activities, well-characterized data sets, and full reporting of required information to state and federal regulatory authorities. AQM's air quality monitoring programs do not include sampling conducted to support industrial hygiene or radiation worker safety programs.

4.1.2.1 Effluent Monitoring

At routine (weekly or monthly) intervals, particulate samples from a continuous effluent sampling system are removed from each building exhaust system identified as having a potential to emit radioisotopes to the environment. Each of these 47-millimeter (mm) filters is radiometrically analyzed for long-lived alpha emitters. The concentration of long-lived alpha emitters is indicative of effluent quality and overall performance of the high-efficiency particulate air (HEPA) filtration system. If the total long-lived alpha concentration for an

240

effluent sample exceeds the Site action level of 0.02 picocuries per cubic meter (pCi/m^3), a follow-up investigation is conducted to determine the cause and to evaluate the need for corrective action within the building.

Historically, at the end of each month, individual samples from each exhaust system were composited into larger samples by location. Beginning in fiscal year 1996 (FY96), samples from minor (insignificant, locations having no potential to emit significant quantities of radioactive materials) emission locations have been collected monthly and composited on an annual basis. Filters from significant sources [having the potential to contribute more than 0.1 millirem (mrem) per year (yr) effective dose equivalent (EDE), uncontrolled, to any member of the public] are analyzed on a monthly basis.

Radionuclides are extracted from these filter composites and subjected to radiochemical separation and alpha spectral analysis, which quantifies specific alpha-emitting radioisotopes. Analyses are performed for specific isotopes of plutonium (Pu), uranium (U), and americium (Am). In addition, tritium (H-3) samples are collected three times weekly at four locations. Detection limits are established to ensure that these radionuclides can be detected at concentrations that would yield a dose to any member of the public equal to 10% of the regulatory standard, using Appendix E guidelines from 40 CFR 61.

4.1.2.2 Ambient Monitoring

The RAAMP monitors airborne dispersion of radioactive materials from the Site into the surrounding environment. Thirty-five samplers comprise the RAAMP network. Twelve of these existing samplers have been included in the perimeter network used to satisfy compliance demonstration requirements under the CAA using environmental measurements; the others are used to characterize exposure and plume path should there be an accidental release from the Site, or for determining local impacts from remediation projects. Samplers operate continuously at a volumetric flow rate of approximately 40 cubic feet per minute (ft^3/min), collecting airborne particles on two collection surfaces. Coarse particles (larger than about 10 micrometers diameter) are collected on an oiled impactor surface, fine particles (smaller than 10 micrometers) are collected on glass fiber filters; and the two samples can be analyzed independently. Samples from the compliance demonstration samplers are routinely analyzed for selected isotopes of Pu, U, and Am, as well as samples from a sampler located near the most significant source area on the Site, the 903 Pad.

4.1.2.3 Meteorological Monitoring

Meteorological monitoring is conducted on Site by use of a 61-meter (m) tower instrumented at four levels (ground level and 10, 25, and 60 m). It is designed to provide support for routine monitoring and assessments, and emergency response. A redundant, instrumented, 10-m tower is located near the primary tower to provide backup data support.

216

4.2 Rad NESHAP Compliance Monitoring

The Site must demonstrate compliance with the Rad NESHAP air emission monitoring requirements and dose standards. This demonstration is accomplished two ways at present, using traditional effluent monitoring and modeling, and using ambient monitoring. Ultimately, compliance will be demonstrated only through ambient monitoring

4.2.1 Effluent Compliance Monitoring

To demonstrate compliance using effluent monitoring, the following critical inputs must be evaluated.

Inputs:

- Monitored concentrations of Pu-239/240, Am-241, U-233/234, U-238, and H-3 from applicable emission sources;
- Site-specific meteorology for the year that the monitored data are reported;
- Resuspension coefficient for soils;
- Documentation of emissions potential from all unmonitored Site activities having potential to emit radionuclides;
- Verification of low emissions for sources not subject to continuous monitoring requirements; and
- Quality assurance of all monitored data.

Boundaries:

Spatial: All areas hosting activities on the Site that could impact off-Site populations.
Current effluent sampling (stack sampling) is occurring at 52 locations within buildings located throughout the Industrial Area.
RAAMP samplers sited with a density that would typically capture a plume that has duration of two hours or more (35 locations).

Temporal: Annual dose estimates.
Quarterly estimates of emissions reported to public.
Monthly data from significant emission points to generate 12-month rolling average.

242

Weekly or monthly alpha-activity screening analyses from effluent sources.

Decision Statement:

IF The estimated radiological dose to any member of the public is greater than 10 mrem/yr due to Site operations—

THEN The Site is out of compliance.

Point sources (significant sources) that have an estimated uncontrolled (without HEPA filtration) potential to result in an EDE to any member of the public greater than 0.1 mrem/yr require continuous effluent monitoring for radionuclides. Current data from this monitoring yield estimated doses that are three orders of magnitude below the regulatory standard at the Site boundary.

IF The Site cannot use standard prescribed monitoring methods to characterize the emissions from a regulated emission source—

THEN The Site must obtain approval for an alternative methodology from the regulatory agency having primacy.

The use of ambient monitoring has been proposed as a plausible alternative sampling method to document dose to potential public receptors and demonstrate compliance.

Monitoring Requirements:

A continuous effluent monitoring system must be installed and/or activated for analytes identified in above inputs. For point sources (significant sources) that have an estimated uncontrolled potential to result in a dose to any member of the public greater than 0.1 mrem/yr (significant sources), the continuous monitoring system samples are analyzed monthly. Other ducts or vents yielding potential doses that are less than 0.1 mrem/yr (insignificant sources) are at present continuously sampled; these sample filters are collected monthly and analyzed as an annual composite sample from each location.

Detection limit may be defined as: "The smallest amount of sample activity using a given measurement process that will yield a net count for which there is confidence at a pre-determined level that activity is present." Table 4-1 shows the minimum detectable activity (MDA) or detection limits for various effluent analyses which are required of the off-Site laboratories that perform the analyses (on a per sample basis). MDA values calculated for individual analyses may vary depending on actual sample volume, chemical recovery, and analytical blank variability.

263

4.2.2 Ambient Rad-NESHAP Compliance Monitoring

Following recent approval actions from EPA Region VIII and CDPHE, ambient monitoring is also used to satisfy the regulatory requirement to demonstrate compliance with the 10-mrem/yr dose standard.

Table 4-1
Detection Limits (MDA) for Effluent Air Samples

Parameter	Required Minimum Detectable Activity (per sample) (pCi)	Approximate Sample Volume (m^3)	MDA (pCi/m^3)
Pu-239/240	0.14	7,340	1.91×10^{-5}
U-234	0.59	7,340	8.04×10^{-5}
U-238	0.59	7,340	8.04×10^{-5}
Am-241	0.18	7,340	2.45×10^{-5}
Tritium (H-3)	4.0	190	0.02

Notes:

pCi = Picocuries
Am = Americium
Pu = Plutonium
m^3 = Cubic meters
MDA = Minimum Detectable Activity
U = Uranium

Samples from selected ambient sites that have been demonstrated by dispersion modeling to have a reasonable probability of capturing the highest potential ambient concentrations due to source emissions (perimeter samplers) are being collected and analyzed on a monthly basis. Analytes include Pu-239/240, U-234, U-238, and Am-241. Table 4-2 gives the required analytical detection limits (MDA) for the ambient sampling network.

244

Table 4-2
Detection Limits (MDA) for Ambient Air Sampler

Parameter	Required Minimum Detectable Activity (per individual filter) (pCi)	Approximate Sample Volume (m^3)	MDA (pCi/m^3)
Pu-239/240	0.14	48,937	4.09×10^{-6}
U-233/234	0.59	48,937	1.70×10^{-5}
U-238	0.59	48,937	1.70×10^{-5}
Am-241	0.18	48,937	5.10×10^{-6}

Notes:

There are two separate filter substrates per sample.

pCi	=	Picocuries	Am	= Americium
m^3	=	Cubic meters	Pu	=Plutonium
MDA	=	Minimum Detectable Activity	U	=Uranium

4.3 Meteorological Monitoring

Continuous meteorological monitoring is conducted in the northwest Buffer Zone at a 61-m tower, instrumented at four levels (ground and 10, 25, and 61 m). Data are collected for wind speed, wind direction, temperature, relative humidity (dew point), solar radiation, precipitation, and a calculated sigma-theta (used to determine Pasquill-Gifford stability classes). Data are used as inputs for all air quality and emergency response dispersion modeling. Data are also used as inputs to CERCLA risk assessment calculations and hydrogeological assessments.

4.3.1 Data Use for Rad NESHAP

Collected meteorological data are used as Site-specific inputs to the Rad NESHAP compliance modeling. Inputs to the modeling calculations require annually averaged meteorological data. Continuous monitoring is required to collect representative annual values.

4.3.2 Data Use for Emergency Preparedness

Data also provide real-time input to the Site-specific emergency response model (Computer Assisted Protective Action Recommendations System [CAPARS], formerly the Terrain Responsive Atmospheric Code [TRAC]). Fifteen-minute averaged data are used to calculate the real-time movement of a pollutant plume as it disperses from the location of an accident. Five CDPHE-operated meteorological towers, as well as other nearby meteorological stations, also provide support to Site emergency response modeling.

2165

4.3.3 Data Use for Other Compliance Modeling

Meteorological data are basic inputs into various regulatory and research models used at the Site. AQM uses screening and predictive models to assess emissions impacts on the public and the environment. Exceedance of calculated thresholds may require implementation of pollution control measures and/or monitoring requirements. Modeling is also being performed to support the Actinide Migration Study, with meteorological data feeding into both the erosion modeling and air dispersion/deposition modeling efforts.

4.3.4 Meteorological Monitoring Specifications

The following data quality specifications are common to all three of the above data needs. Inputs to the meteorology decisions include:

Inputs:

- Site-specific wind speed, wind direction, temperature, and relative humidity;
- Site-specific rainfall data;
- Atmospheric stability class calculations; and
- Solar radiation data.

Boundaries:

Spatial:	Representative air flow patterns impacting the Site. A minimum of 10 m above ground level.
Temporal:	Continuous data, averaged every 15 minutes. Hourly averaged data, calculated from the 15-minute averages. Annually averaged data and frequency distributions.

Decision Statement:

IF	Regulatory compliance, emergency response, or risk assessment modeling is performed at RFETS—
THEN	Standard, consistent, Site-specific meteorological summaries shall be used to ensure most representative model results.

2666

Monitoring Requirements:

Operate meteorological monitoring station with a 95% or better data capture to provide data inputs in support of Site-required modeling programs. Operation shall follow guidance detailed in the *Site Meteorological Monitoring Plan* (DOE, 1994a).

4.4 CDPHE Air Monitoring

4.4.1 Air Pollution Control Division (APCD) Non-Radiological Ambient Air Quality Monitoring

Pollutants regulated under the CAA National Ambient Air Quality Standards (NAAQS) are monitored along the Site perimeter by the CDPHE Air Pollution Control Division (APCD). Ambient sampling for beryllium (Be) is also performed by CDPHE to verify compliance with CAQCC Regulation No. 8.

4.4.1.1 Ambient Nitrogen Dioxide (NO_2) and Particulate Monitoring

Inputs:

- Ambient particulate and NO_2 concentrations; and
- Meteorological data, especially wind direction.

Boundaries:

Spatial: Property boundaries. Data characterizes concentrations as air enters the Site and leaves the Site. These concentrations continually change with wind direction.

Temporal: Continuous NO_2 measurements. No specified time increment for determining difference but averaging time for NO_2 standard is annual.

Particulates. Every sixth day, a 24-hour sample is collected and used to generate a quarterly estimate. Averaging times for PM_{10} standards are 24 hours and annual.

Decision Statement:

IF A perimeter monitor detects an exceedance of an ambient NO_2 [0.053 parts per million (ppm)] or fine particulate (PM_{10}) [50 micrograms per cubic meter ($\mu g/m^3$) annual and 150 $\mu g/m^3$ 24-hour] standard, and the difference in concentrations of PM_{10} or NO_2 at upwind monitors and downwind

2671

	monitors indicates that the Site may be a primary contributor to the exceedance—
THEN	The Site's operating permit may be reopened and potentially revised to mitigate the exceedance.

4.4.1.2 Beryllium Monitoring

Inputs:

- Emission source assessment data, Air Pollutant Emission Notices (APENs); and
- Stack test data.

Boundaries:

Spatial:	Emission points (stacks) of applicable sources.
Temporal:	24-hour sampling average.

Decision Statement:

IF	Be emissions from sources subject to CAQCC Regulation No. 8 (40 CFR 61, Subpart C) exceed 10 grams per 24-hour period—
THEN	CDPHE may take enforcement action.

Inputs:

- Ambient Be sampling data; and
- Meteorological data.

Boundaries:

Spatial:	Site fenceline.
Temporal:	Samples are composited for quarterly decisions.

2168

Decision Statement:

IF Ambient Be concentrations due to sources subject to CAQCC Regulation No. 8 (40 CFR 61, Subpart C) exceed 0.01 $\mu g/m^3$ averaged over a 30-day period—

THEN CDPHE may take action to identify the source.

4.4.2 Laboratory and Radiation Services Division (LARS) Radiological Ambient Air Quality Monitoring

CDPHE's Laboratory and Radiation Services Division (LARS) has monitored radioactive emissions from the Site since 1969. The primary purpose for this sampling has been to provide an independent assessment of public exposure to radioactive material released from the Site. LARS's monitoring program has provided validation of sampling methods used by Site organizations, confirmation of Site measurements of Pu in air, and, on occasion, helped identify errors made by Site monitoring personnel. The data are compared to Derived Concentration Guides for nonoccupationally exposed persons. Historically, the desirability of an independent monitoring program outweighed concerns about costs, partly due to public mistrust of monitoring performed by DOE contractors.

Currently, concerns about releases during accidents or off-normal situations continue to arise and may increase as cleanup progresses. Emergency response plans for the Site include provisions for sampling environmental media after a plume dissipates. The continuous air samplers operated by LARS allow the state to begin fulfilling this obligation immediately after a release and would ultimately provide more accurate exposure assessments than output from CAPARS or other models. Routine analyses of these samples provide baseline data for comparison to known or suspected releases.

In the future, data from LARS air samplers will support APCD in its evaluation of Site compliance with NESHAP requirements, as well as providing documentation for ALARA decisions, which may arise during cleanup.

4.4.2.1 Radiological Ambient Air Quality Monitoring

Inputs:

- Adequate historical and baseline data and defensible estimates of normal variation; adequate QA/QC measures on laboratory analyses. Analytes include gross alpha/gross beta on weekly samples, and Pu and Am on quarterly composites. To fully satisfy NESHAP requirements, U would have to be added to the quarterly list, should these samples be used to supplement DOE's Site measurements.

Boundaries:

Spatial: LARS currently samples air at 12 locations: 4 east of the Industrial Area, 4 in the Buffer Zone, and 4 near the Site boundary. Total suspended particulates (TSP) are sampled at all locations. One location from each category has a collocated PM_{10} sampler.

Temporal: Individual samples are collected continuously for one week. Fractions of 13 samples are composited and analyzed as quarterly samples, corresponding to calendar quarters.

Decision Statement:

IF Any measurement of radionuclides in the air exceeds the normal variation seen in historical and baseline measurements—

THEN A series of actions may be taken.

These actions include, but are not limited to, re-analysis of composite samples for verification; analysis of individual samples included in the composite; a request for analysis of comparable samples from the nearest DOE ambient samplers, ComRad Program samplers, and/or APCD samplers; a request for investigation or explanation of elevated results from DOE or its contractor; a calculation of public dose and/or risk; and a presentation of analysis and investigation results to CDPHE management, and in public forums, as requested.

IF The Student's T-test or other appropriate test to determine if the latest data point exceeds the seasonally adjusted historical range indicates exceedance of the normal range—

THEN Investigate cause; otherwise trend analysis.

Limits On Decision Errors:

Since Pu and Am have historically constituted a small fraction of the measured gross alpha concentration, extremely high concentrations of these nuclides would be required to result in an elevated gross alpha result. Such a sample would also be difficult to detect when composited with 12 samples in the "normal" range. Therefore, narrow limits on what is defined as the normal range and a fairly high chance of a false positive result will be necessary to identify any unplanned short-term release. In the absence of real or suspected exceedances, trend analysis should be sensitive to small, upward shifts in concentration, especially in the case of boundary samplers.

210

CDPHE detection limits are calculated at the 95% confidence level. While no specific detection limit is required, Table 4-3 summarizes typical detection limits for APCD and LARS samples, assuming 100% chemical recovery.

Table 4-3
Detection Limits for CDPHE Air Samples

Parameter	Approximate Sample Volume (m^3)	MDA (pCi/m^3)
APCD Pu-239/240	1,500	4.0×10^{-6}
APCD Am-241	1,500	4.0×10^{-6}
LARS Pu-239/240	3,400	1.0×10^{-6}
LARS Am-241	3,400	1.0×10^{-6}

Notes:

pCi	=	Picocuries	MDA	=	Minimum Detectable Activity
Am	=	Americium	Pu	=	Plutonium
m^3	=	Cubic meters	U	=	Uranium

4.4.2.2 Precipitation Sampling

LARS collects samples of precipitation at four locations, one east of the Industrial Area, one near the 903 Pad lip area, one at the Site boundary on Indiana Street, and one at the CDPHE laboratory building in east Denver. All samples are analyzed for tritium. Those near the Industrial Area and at the Site boundary are analyzed for gross alpha/beta, Pu-239/240, and Am-241. It is recognized that the Site vicinity rarely gets enough precipitation for either atmospheric washout or deposition to have significant environmental effects, but these data are collected against the possibility that environmental modeling attains a level of sophistication where such inputs could be useful.

Inputs:

- Location;
- Sample volume;
- Meteorological data; and
- Sample concentration of Am, Pu, gross alpha and gross beta.

221

Boundaries:

Spatial: Sample locations are given above.

Temporal: All precipitation in a calendar quarter is collected and composited. Results correspond to a given quarter.

Decision Statement:

IF Any measurement of radionuclides in precipitation exceeds the normal variation seen in historical and baseline measurements—

THEN A series of actions may be taken. These include, but are not limited to, re-analysis of the samples for verification; analysis of individual ambient air filters from the same quarter; a request for analysis of comparable filters from the nearest DOE, ComRad, or APCD program samplers; a request for investigation of the results from DOE or its contractor; and a request for CDPHE and DOE modeling efforts to examine the environmental effects of such deposition.

Limit on Decision Errors:

All measurements are reported at the 95% confidence level. It is recognized that, historically, there has been an inverse relationship between sample concentration and sample volume.

4.4.2.3 Particle Size Distribution Monitoring

A cascade impactor is used to separate airborne particulate material into seven size fractions. The size distribution of airborne particles is of concern because the size of the particles to which contaminants are attached is a determinant of the degree of hazard they pose; generally, smaller particles are inhaled more deeply and retained in the respiratory system for a longer period of time than larger particles. Both DOE and CDPHE have conducted particle size-distribution studies. The CDPHE studies are more recent and have been performed at the edge of the Industrial Area (just east of the east security fence), in the Buffer Zone, and at the Site perimeter on Indiana Street.

272

Inputs:

- Pu and Am concentrations, suspended particulate material concentrations, Pu/Am ratio and U-234/U-238 ratio, all by particle size, together with International Commission on Radiation Protection (ICRP) data relating to inhalation and retention of particulate material by particle size.

Boundaries:

Spatial: Data collection from the E-1 (east of security fence) is complete, unless additional information is needed. Data collection from the E-2 platform (east Buffer Zone) is also complete. Data collection from E-3 platform (Indiana Street) will be completed in December 1998. Similar data from the D-13 ground level sampler (directly below the E-1 sampler) is still needed.

Temporal: Samples were collected at the E-1 platform for three years; the quantity of data is now probably sufficient to make conclusions about the variability in the particle size distribution (relative amounts in each size fraction) with respect to changes of season and the passage of time. Since the concentrations of airborne contaminants from Rocky Flats are generally lower at the E-2 and E-3 platforms, the uncertainty associated with those measurements may be too great to draw precise or reliable conclusions.

Decision Statements:

IF Results of the size-distribution studies are well quantified and statistically valid—

THEN The results will be made available for future quantitative and qualitative assessments of dose impacts from the Site.

Discussion:

If there is no seasonal variation, annual variation, or variation with distance from the source in the particle size distributions, the estimates of hazards (e.g., radiation dose) from airborne particulate material will be mostly straightforward and the overall precision and certainty of conclusions will be high. If the mean particle size (or more broadly, the particle size distribution) is approximately the same as assumptions that have been made about particle size, then decisions that have been made by CDPHE in the past about the health effects of Rocky Flats and for emergency planning have been reasonably conservative, but not excessively so. Similarly, if the mean particle size (or more

273

broadly, the particle size distribution) is approximately the same as what has been measured in the past by the Site, then reconciliation of the data sets, and the conclusions that have been drawn in the past, will be straightforward. If consensus can be gained as to the reliability and utility of the data set, the results will provide a useful tool for reconstruction of estimates of hazards from the past, for estimating the health-related impacts of remediation and other future decisions, and for emergency planning.

Limits On Decision Rule:

Not necessary. LARS typically calculates 95% confidence intervals on all radiometric measurements, and plans to place 95% confidence intervals on estimates drawn from the data. Other statistics will accompany the data set to allow future estimations to be made at whatever confidence level is selected. Data precision in measurements is as high as current environmental survey techniques are likely to allow.

4.5 Project-Specific Monitoring

Environmental restoration programs require air quality assessments to evaluate potential emissions from planned remedial action projects. As a result of these assessments, air quality monitoring may be performed during the project due to either risk assessment or CAA air quality screening results. Project-specific ambient monitoring may also be triggered by soil screening measurements performed for radiation worker protection.

4.5.1 Interim Measures/Interim Remedial Action (IM/IRA) Ambient Volatile Organic Compound Monitoring

The Site's remediation and deactivation operations within the Industrial Area had the potential emit significant concentrations of volatile organic compounds (VOCs). During FY95 and FY96, a VOC monitoring program was performed along the perimeter of the Rocky Flats Industrial Area. The program's purpose was to provide data on background levels of various VOCs that had been identified as Constituents of Potential Concern or Compounds of Interest in the Final IM/IRA Decision Document for the Rocky Flats Industrial Area (DOE, 1994b). The IM/IRA Decision Document outlined a strategy to monitor VOC emissions that may occur during Site building deactivation projects. This monitoring strategy would build upon the FY95/FY96 baseline monitoring effort.

The Site-wide DQO process that took place in FY96 determined that existing point and fugitive sources of VOCs had been sufficiently characterized by this program. As a result, and in consideration of future data requirements as identified during the DQO process, routine ambient VOC monitoring, will not be performed during decontamination and decommissioning (D&D) activities. Instead, emission calculations and risk assessments will be the primary decision tools used to determine the need to implement source controls.

274

4.5.2 Project-Specific Ambient Radiological Monitoring

Whenever a D&D or environmental restoration project is planned that has a significant potential to release radionuclides, the existing on-Site and perimeter RAAMP network will be employed to provide project-specific monitoring. Samplers in the immediate vicinity of the project will have filters exchanged weekly instead of monthly. Filters from these "project-specific" monitors will be screened for total alpha/beta contamination and the results compared to predefined notification levels specific to each project and each sampler. The notification levels will represent the radionuclide concentrations at each project-specific sampler that would equate to a particular off-Site dose. Notification levels will be set to represent the expected release rate for the project and at a level representing a 5 mrem cumulative off-Site dose (half the annual Rad NESHAP standard) if emissions continued at that weekly rate for the entire project.

The alpha/beta screens will allow feedback to the project personnel within a few days after the filters are exchanged. If emissions exceed the higher notification level, the sample in question will be sent to an off-Site laboratory to perform an expedited isotopic analysis. If necessary, results of the alpha/beta screening may be used by project personnel to adjust schedule or project controls to ensure Site-wide compliance with the 10-mrem standard. If warranted, sample changes can be accelerated at other RAAMP samplers or additional expedited isotopic analyses may be requested at any time during the project.

Inputs:

- Building emissions inventory or list of potential contaminants of concern that may be disturbed/emitted by project;
- Site-specific meteorology; and
- Building or operation project plan and project schedule.

Boundaries:

Spatial: Perimeter of source being evaluated or monitored.

Upwind and downwind sampling locations. Two sites would be a minimum; five are typical to ensure representative sample capture relative to wind direction.

Temporal: Continuous sampling during periods of potential high emissions for multiple days. Continuous sampling is needed to capture sufficient sample volume for analysis.

Decision Statement:

IF — Remediation projects with the potential to emit radionuclide particulates in concentrations that would exceed a notification level corresponding to half the annual Rad NESHAP standard or other Site action limits are performed—

THEN — Emissions to off-Site receptors will be documented by continuous ambient monitoring.

Monitoring Requirement:

For Industrial Area or Buffer Zone monitoring, specific RAAMP samplers must be activated as necessary to gather representative data. The actual number of samplers and their locations must be determined based on the location and extent of the source area. The periods and frequency of sampler operation would be determined by the project activities, action levels established for the projects, and duration of remedial activities that have the potential to emit radionuclide materials.

4.6 <u>Outstanding Issues</u>

4.6.1 Radiological NESHAP Ambient Monitoring

Currently, the Site demonstrates compliance with the annual 10 mrem public dose standard in 40 CFR 61, Subpart H through both ambient monitoring, and monitoring and dispersion modeling of the effluent (monitored point) sources, and emission estimation and dispersion modeling of the non-point and unmonitored point sources, to determine the dose to the most impacted off-Site resident. The Site has historically demonstrated Rad NESHAP compliance using the latter approach only.

- Ambient monitoring has been tentatively approved to demonstrate compliance based on the following considerations: The Site continues to work toward cleanup and closure, and buildings that have contained significant quantities of radionuclide materials will be deactivated. Following limited contaminant removal, the ventilation systems may be sealed and turned off. In other cases, equipment removal and structural demolition will be carried out, with the existing ventilation systems disrupted or dismantled at some point in the process. In either case, a lack of directed flow from the contaminated areas would preclude normal effluent monitoring in these buildings. Such buildings will become non-point (diffuse) sources of airborne radionuclides.

2716

- Environmental restoration projects present a similar dilemma. Radionuclide emissions will occur from disturbance of contaminated soils and debris, as well as from waste treatment, handling, and packaging activities. As with building D&D, normal effluent monitoring of most such activities will not be possible.

- As buildings are closed and become diffuse sources, and as the number of environmental restoration projects increases, the number of monitored effluent sources will decrease and the number of unmonitored sources at the Site will increase. In such cases where diffuse sources are primary contributors to dose, an alternative environmental monitoring approach becomes particularly appropriate for demonstrating compliance with the public dose standard of 40 CFR 61, Subpart H.

In recognition of these conditions, DOE submitted a proposal to EPA and CDPHE in July 1997 describing an alternative compliance demonstration approach based on the existing 12 perimeter RAAMP samplers plus one additional sampler to be located at the northeast Site boundary. Filters would be changed at the samplers monthly and analyzed for selected Pu, U, and Am isotopes.

Subsequent discussions resulted in an agreement to relocate one of the existing monitors and to install two additional monitors to the north and northeast of the Site, near the perimeter. Under the alternative compliance demonstration method, effluent monitoring will be discontinued at insignificant point sources on Site and the ambient network will be used to demonstrate low emissions from these locations. Emissions from significant point source locations will continue to be monitored with effluent samplers. For a two-year transition period starting with the CY98 reporting period, emissions from the site, including estimated diffuse source emissions , will be modeled and the resulting EDE reported to allow comparison with environmental measurements. CDPHE approval was granted in September 1997. EPA's tentative approval followed in December 1998, with final approval scheduled in 1999.

4.6.2 Radiological NESHAP Regulatory Authority

Since regulatory primacy has not yet been transferred from EPA Region VIII to CDPHE, discussions on alternate monitoring protocols and other compliance issues include both agencies.

4.6.3 Beryllium Effluent Stack Sampling

A review of future planned Be foundry operations may reveal a need to conduct effluent sampling for Be, such activities being subject to CDPHE Regulation No. 8. Emissions to the atmosphere are not allowed to exceed 10 grams of Be over a 24-hour period.

2-77

4.7 References

Colorado Department of Public Health and Environment, 1978. *Rules and Regulations Pertaining to Radiation Control, Part IV,* Denver, Colorado (as revised through December 30, 1985).

U.S. Department of Energy, 1994a. *Meteorological Monitoring Plan*, Air Quality Branch, Rocky Flats Plant, Golden, Colorado, December 5 (unpublished report).

U.S. Department of Energy, 1994b. *Final Interim Measures/Interim Remedial Action Decision Document for the Rocky Flats Industrial Area*, Rocky Flats Plant, Golden, Colorado, March.

Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

Ecological Monitoring

September 1999

279

Table of Contents

280

5.0 ECOLOGICAL MONITORING

5.1 Introduction

Ecological monitoring at Rocky Flats Environmental Technology Site (RFETS or the Site) has historically focused on characterization of the ecological components within the Buffer Zone and compliance with a variety of regulatory drivers [e.g., the Endangered Species Act, the Fish and Wildlife Coordination Act, the Bald Eagle Protection Act, the Migratory Bird Treaty Act, wetlands regulations, weed control acts, the National Environmental Policy Act (NEPA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)]. The monitoring requirements presented here were established through implementation of the data quality objective (DQO) process and represent a program that emphasizes natural resource conservation, habitat management, and regulatory compliance.

Since the Ecological Monitoring Program deals with a large and dynamic natural system, where established endpoints (i.e., discharge permit limitations) do not exist, a qualitative, rather than a statistical, approach was adopted. The program, therefore, focuses on collection of data necessary to ensure regulatory compliance and to assess the success or failure of the U.S. Department of Energy's (DOE's) resource conservation and habitat management efforts. These conservation and management efforts are aimed at achieving a set of management goals consistent with DOE's demonstrated desire to practice ecosystem management (Congressional Research Service, 1994) and resource conservation (DOE, 1994) on its properties.

These policies provide part of the basis for developing a set of environmental management goals and associated monitoring requirements that support ecological management decision making as part of the *Integrated Monitoring Plan* (IMP).

This chapter describes the technical and regulatory basis for the approach to ecological monitoring at the Site.

5.2 Ecological Conservation and Management Goals and Objectives

5.2.1 Goals

In general, the goals include conservation of currently viable ecosystems, detection and management of problems or undesirable impacts to the Buffer Zone before they become severe, protection of unique and ecologically valuable natural resources in the Buffer Zone, protection of any special-concern species (threatened, endangered, candidate, proposed, state-listed, or other sensitive species), and compliance with applicable wildlife and natural resource protection regulations. The goals are consistent with regulatory compliance and the DOE Buffer Zone Policy.

282

Specific conservation and management goals for the major identified vegetation communities and one species of particular interest are presented in Table 5-1.

Table 5-1
Conservation and Management Goals

Vegetation Community	Management Goal
Xeric Tallgrass Prairie	Maintain current quantity (area) and quality of the vegetation community, and maintain the current populations of bird and mammal species characteristic of xeric tallgrass prairie.
Tall Upland Shrubland	Maintain current quantity (area) and quality of the vegetation community, maintain the current populations of bird and mammal species characteristic of tall upland (seep) shrubland, and maintain current population numbers and extent of Preble's meadow jumping mice within the habitat.
Great Plains Riparian Woodland Complex	Maintain current quantity (area) and quality of the vegetation community, maintain the current populations of bird and mammal species characteristic of the riparian woodland complex, and maintain current population numbers and extent of Preble's meadow jumping mice within the habitat.
High Quality Wetlands	Maintain current quantity (area) and quality of the vegetation community, and maintain the current populations of bird and mammal species characteristic of the largest contiguous high quality wetlands (Rock Creek and Antelope Springs/Apple Orchard Springs Wetlands Complexes).
Mesic Mixed Grassland	Maintain current contiguous extent of mesic mixed grassland for heavily and frequently used wildlife areas, and maintain the current populations of bird and mammal species characteristic of this vegetation community.
Aquatic Community	Maintain current populations of aquatic organisms including invertebrate and vertebrate species characteristic of the stream and pond environment at the Site.
Species of Particular Interest	
Preble's Meadow Jumping Mouse Populations	Maintain the current quantity (area) and quality of Preble's meadow jumping mouse habitat and protect all extant populations of Preble's meadow jumping mice.

283

5.2.2 Objectives

The two primary objectives for the ecological monitoring are to determine if the Site is:

- Meeting ecological conservation and management goals; and

- Complying with regulatory requirements.

5.3 Descriptions of Vegetation Communities and the Preble's Meadow Jumping Mouse Populations

Vegetation communities at the Site provide specific habitats for associated wildlife, rare plants, and unusual plant associations.

5.3.1 Xeric Tallgrass Prairie

The xeric mixed grassland unit selected for specific monitoring at the Site is the xeric tallgrass prairie. Identification of this vegetation community at the Site is based on the presence of big bluestem, little bluestem, prairie dropseed (*Sporobolus heterolepis*), Indian-grass (*Sorghastrum nuntans*), and/or switchgrass (*Panicum virgatum*). In general, only big bluestem and little bluestem occur very commonly or abundantly at Rocky Flats. These five species are considered to be tall grass prairie relicts. When they are found in the xeric mixed grassland community with a combined cover of approximately 10% or more, the community is classified as xeric tallgrass prairie. The soil under the xeric tallgrass prairie is visibly cobbly on the surface and considered to be a sandy clay loam. This vegetation community covers the high, rocky pediment on the western one-third of the Site. The xeric tallgrass prairie vegetation community was selected at the Site for special conservation efforts due to its nationwide rarity.

The xeric needle-and-thread grass prairie, which is the other unit of xeric mixed grassland at the Site, is also considered rare, but it is not large enough to justify special management efforts. Xeric needle-and-thread grass prairie is differentiated from xeric tallgrass prairie by a greater cover of needle-and-thread grass and New Mexico feather grass (*Stipa neomexicana*), and very little cover of the big bluestem and little bluestem or other tallgrass species. Generally, the soils are not as visibly cobbly as in the xeric tallgrass prairie and have a higher visible component of caliche at the soil surface. This vegetation community occupies the tops of many of the eastern-most ridges of the Site.

5.3.2 Mesic Mixed Grassland

Mesic mixed grassland is characterized by western wheatgrass (*Agropyron smithii*) and blue grama grass (*Bouteloua gracilis*). Other common species include green needlegrass (*Stipa viridula*), Canada bluegrass (*Poa compressa*), and Kentucky bluegrass (*Poa pratensis*). The mesic grassland has a more solid turf appearance in contrast to the bunchgrass appearance of the

284

xeric mixed grasslands. Soils are clay loams and do not have the cobbly surficial appearance typical of xeric mixed grassland soils. Most hillsides at the Site are considered mesic mixed grassland habitat.

The quality of these grasslands varies considerably across the Site. The mesic mixed grassland on the western side of the Site has been and continues to be significantly degraded by diffuse knapweed (*Centaurea diffusa*). Mesic mixed grassland on the eastern portion of the Site has been degraded by weed species such as Japanese brome (*Bromus japonicus*), alyssum (*Alyssum minus*), and musk thistle (*Carduus nutans*) more than those on the western edge of the Site. For classification purposes, if western wheatgrass and blue grama grass form an understory beneath non-native species, then the grassland is classified as mesic mixed grassland.

Mesic mixed grasslands comprise one of the largest contiguous vegetation communities at the Site. In addition to its essential role as a foraging habitat, the size and isolation of the vegetation community often makes it very important to some wildlife species,. A wide variety of grasslands birds breed and forage in this habitat. Small mammals are abundant and diverse and provide a suitable prey base for a variety of avian and mammalian predators. Many of the species supported by this vegetation community are rare or special concern.

5.3.3 High Quality Wetlands (Rock Creek and Antelope Springs/Apple Orchard Springs Complexes)

The high quality wetlands selected for monitoring and specific conservation efforts are those Site wetlands with the largest contiguous areas and the most complex plant associations. The Rock Creek wetlands are a large, seep-fed wetland complex extending approximately one mile from the foot of the eastern-most seep-fed wetlands to the western-most short marsh areas.

The Antelope Springs/Apple Orchard Wetland Complex encompasses the predominantly wet meadow, short marsh, and tall marsh habitat mosaic of upper Woman Creek Drainage Basin. These are also seep-fed wetlands that depend on groundwater discharge for their continued existence.

Predominant vegetation in these wetlands includes cattails (*Typha sp.*) and bulrush (*Scirpus sp.*) in tall marsh community; Nebraska sedge (*Carex nebraskensis*) and Baltic rush (*Juncus balticus*) in short marsh habitat; and prairie cordgrass (*Spartina pectinata*), redtop (*Agrostis stolonifera*), showy milkweed (*Asclepias speciosa*), and Missouri iris (*Iris missouriensis*) in the wet meadow habitat.

These wetlands support a variety of terrestrial and aquatic organisms. Portions of these wetlands have been designated as prime Ute Ladies'-tresses (*Spiranthes diluvialis*) habitat (a federally listed threatened plant that may occur at the Site). Other parts support sensitive amphibian species and waterfowl. Many predatory mammals and bird species are dependent on these areas as hunting and foraging grounds due to their high prey species productivity.

2855

5.3.4 Tall Upland Shrubland

The tall upland (seep) shrubland is comprised of stands of hawthorn (*Crataegus erythropoda*), chokecherry (*Prunus virginiana*), and occasionally wild plum (*Prunus americana*). Tall upland shrubland is found primarily on north-facing slopes above seeps, wetlands, and streams in the northern portion of the Site in the Rock Creek drainage. Small units also occur in other drainages of the Site. This vegetation community may be unique, having had no other units identified outside the general Rocky Flats vicinity, and is an important one to the resident mule deer population. Mule deer are highly reliant on tall upland shrubland for fawning cover, winter thermal cover and browse, and summer shade and isolation cover. A number of rare bird species (e.g., bluegray gnatcatchers and ashthroated flycatchers) occupy this community as well. Some units of tall upland shrubland also provide habitat for the rare Preble's meadow jumping mouse.

5.3.5 Great Plains Riparian Woodland Complex

Riparian areas are well known for the diversity of plant and animal species they support. The riparian woodland complex at the Site is a combination of two vegetation community classifications: riparian woodland and riparian shrubland. Riparian woodlands are found primarily along the drainage bottoms on Site. Due to the mosaic of trees and shrubs in the riparian areas, a contiguous mixture of both trees and shrubs is considered as the riparian woodland complex. This complex is characterized by stands of plains cottonwood (*Populus deltoides*), peach leaf willow (*Salix amygdaloides*), Siberian elm (*Ulmus pumila*), and silver poplar (*Populus albus*). Shrub species include chokecherry *(Prunus virginiana)*, snowberry (*Symphoricarpos occidentalis.*), coyote willow (*Salix exigua*), leadplant (*Amorpha fruticosa*), and others.

Riparian woodland complex is an important habitat for a different songbird association than the grasslands and shares some species with the tall upland shrubland. Several of the bird species that use the riparian woodland complex as foraging and nesting cover are rare species (e.g., blue grosbeaks). This vegetation community is also seasonally important to the resident mule deer herd as shelter, forage source, and fawning grounds. Large cottonwood trees imbedded within this unit provide nesting habitat for several raptor species, including great horned owls, red-tailed hawks, Swainson's hawks (a Colorado "at-risk" species), and American kestrels. Riparian woodland complex supports the greatest number of Preble's meadow jumping mice at the Site and is considered typical habitat for this species. The majority of monitoring, protection, and management of Preble's meadow jumping mouse habitat will occur in this community.

286

5.3.6 Aquatic Community

During 1991-1992, the Operable Unit 1 Ecological Evaluation (DOE 1992a) and the Baseline Characterization (DOE, 1992b) studies conducted sampling to characterize the aquatic community at the Site. This effort included widespread benthic invertebrate sampling across the Site, and limited fish sampling in ponds and some streams. No fish inventory has been made since then. The Colorado Wildlife Commission (CDOW) has listed five species of small fish native to the South Platte River drainage as State endangered (the northern redbelly dace, southern redbelly dace, plains minnow, suckermouth minnow, and lake chub), and two as threatened (the brassy minnow and common shiner) (CDOW, 1998). In light of these potential listings, and the prior recommendation in the *1996 Annual Wildlife Survey Report* (Kaiser-Hill, 1997a) that fish sampling be added to the Natural Resource Compliance and Protection Program's ecological monitoring effort, Kaiser-Hill has authorized the addition of this study to the ecology program (Kaiser-Hill, 1997b). Sampling will initially focus on streams, with ponds sampled on alternate years.

The aquatic ecosystem consists of a network of ephemeral and intermittent streams across the Site, with some old stock ponds scattered across the Site. In the Walnut Creek and Woman Creek drainages, there are several water management impoundments that retain large, permanent ponds of water. Additionally, numerous seep springs feed streams at the Site and provide limited wetland habitat themselves.

While sampling of the aquatic community will attempt to quantify populations through relative abundance sampling, it should be understood that aquatic sampling in upper headwaters streams may not provide sufficient numbers to estimate stream populations. The amount of viable habitat is extremely limited due to the ephemeral nature of these streams. To attempt to sample 100% of the individuals in such habitat could result in serious damage or destruction to the habitat itself; therefore, only representative sampling of this fragile habitat will be performed.

5.3.7 Preble's Meadow Jumping Mouse Populations

Preble's meadow jumping mouse (*Zapus hudsonius preblei*) is of particular concern at the Site because it is listed as threatened by the U.S. Fish and Wildlife Service (USFWS). This listing provides special protection for the species under the Endangered Species Act.

Preble's meadow jumping mice have been recorded in all major drainages of the Site: Rock Creek, Walnut Creek, Woman Creek, and the Smart Ditch drainages. Native plant communities in these areas provide a suitable habitat for this small mammal. Jumping mice at Rocky Flats are restricted to riparian areas and pond margins, apparently requiring multi-strata vegetation with abundant herbaceous cover. Preble's meadow jumping mouse populations at the Site are frequently found in association with coyote willow. Recent studies have produced a better understanding of population centers of the species, and studies over the past several years have also provided data to help estimate numbers of individuals within each population unit.

257

5.4 Monitoring DQOs by Vegetation Community

DQOs were developed for monitoring in five important vegetation communities in support of the following key decision:

- Given baseline information, determine whether to reevaluate current management practices to achieve specific vegetation community management goals.

Results from the monitoring of these communities will facilitate the conservation and management of these resources, as well as associated wildlife, rare plants, and unusual plant associations.

5.4.1 Xeric Tallgrass Prairie Vegetation Community

Inputs:

- Extant area of xeric tallgrass prairie;
- Baseline estimates of plant, bird, and mammal species richness;
- Baseline estimates of bird and mammal presence or absence;
- Annual estimates of plant, bird, and mammal species richness;
- Annual weed mapping and photo surveys;
- Annual assessment of endpoints for the vegetation community and wildlife populations;
- Anticipated or estimated impact area of any proposed project;
- Identification of any plant or wildlife species populations of interest; and
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial: Current RFETS geographic boundaries.
All characteristic xeric tallgrass prairie within RFETS.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occurs:

- A measured or anticipated loss of xeric tallgrass prairie from the baseline amount;
- New weed species are reported for the vegetation communities;
- Weed mapping and/or photo surveys indicate weed species are spreading or increasing in the community;
- Weed control assessment monitoring indicates low effectiveness of a treatment option;
- A decline in the plant, bird, or mammal species richness or densities;
- Loss or major population decline of any of the predominant plant, bird, or mammal species from the vegetation community;
- Loss or major decline of any population of an identified plant species of interest or any plant or animal special-concern species; and/or
- Significant change in any of the assessment endpoints–

THEN Evaluate options to achieve the stated goals.

5.4.2 Tall Upland Shrubland Community

Inputs:

- Extant area of tall upland (seep) shrubland;
- Baseline estimates of plant, bird, and mammal species richness;

289

- Baseline estimates of bird and mammal presence or absence;
- Annual estimates of plant, bird, and mammal species richness;
- Annual weed mapping and photo surveys;
- Annual assessment endpoints for the vegetation community and wildlife populations;
- Anticipated or estimated impact area of any proposed project;
- Identification of any plant or wildlife species populations of interest;
- Weed control assessment monitoring, as applicable;
- Biennial estimates of characteristic plant species area, density, height, and canopy cover within known Preble's meadow jumping mouse population areas. One-half the known population areas will be monitored on each alternate year; and
- Baseline estimates of the known Preble's meadow jumping mouse population size estimates.

Boundaries:

Spatial: Current RFETS geographic boundaries.
All characteristic tall upland shrubland community within RFETS.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occurs:

- A measured or anticipated loss of tall upland shrubland vegetation community from the baseline amount;
- New weed species are reported for the vegetation community;
- Weed mapping and/or photo surveys indicate weed species are spreading or increasing in the vegetation community;

290

- Weed control assessment monitoring indicates low effectiveness of a treatment option;
- A decline in the plant, bird, or mammal species richness or densities;
- Loss or major decline of any of the predominant plant, bird, or mammal species from the vegetation community;
- Loss or major decline of any population of an identified plant species of interest or any plant or animal special-concern species;
- Significant change in any of the assessment endpoints;
- Structural measurements for any characteristic plant species (e.g., area, density, height, and canopy cover) within a known Preble's meadow jumping mouse population area decreases substantially from baseline;
- The area of known Preble's meadow jumping mouse habitat within the unit decreases substantially from baseline; and/or
- Any known permanent population of Preble's meadow jumping mouse within the habitat unit decreases substantially from baseline—

THEN Evaluate options to achieve the stated goals.

5.4.3 Great Plains Riparian Woodland Complex

Inputs:

- Extant area of riparian woodland complex;
- Baseline estimates of plant, bird, and mammal species richness;
- Baseline estimates of bird and mammal presence or absence;
- Annual estimates of plant, bird, and mammal species richness;
- Annual weed mapping and photo surveys;

291

- Annual assessment endpoints for the vegetation community and wildlife populations;
- Anticipated or estimated impact area of any proposed project;
- Identification of any plant or wildlife species populations of interest;
- Weed control assessment monitoring, as applicable;
- Biennial estimates of characteristic plant species area, density, height, and canopy cover within known Preble's meadow jumping mouse population areas. One-half of the known population areas will be monitored in each alternate year; and
- Baseline estimates of the known Preble's meadow jumping mouse population size estimates.

Boundaries:

Spatial: Current RFETS geographic boundaries.
All characteristic Great Plains riparian woodland complex community within RFETS.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occurs:

- A measured or anticipated loss of riparian woodland complex vegetation community from the baseline amount;
- New weed species are reported for the vegetation community;
- Weed mapping and/or photo surveys indicate weed species are spreading or increasing in the vegetation community;
- Weed control assessment monitoring indicates low effectiveness of a treatment option;
- A decline in the plant, bird, or mammal species richness or densities;

292

- Loss or major decline of any of the predominant plant, bird, or mammal species from the vegetation community;
- Loss or major decline of any population of an identified plant species of interest or any plant or animal special-concern species;
- Significant change in any of the assessment endpoints;
- Structural measurements for any characteristic plant species (e.g., area, density, height, and canopy cover) within a known Preble's meadow jumping mouse population area decrease substantially from baseline;
- The area of known Preble's meadow jumping mouse habitat within the unit decreases substantially from baseline; and/or
- Any known permanent population of Preble's meadow jumping mouse within the habitat unit decreases substantially from baseline—

THEN Evaluate options to achieve the stated goals.

5.4.4 High Quality Wetlands

Inputs:

- Extant wetlands based on 1994 U.S. Army Corps of Engineers wetland map and study (restricted to Buffer Zone only);
- Extent of wetlands will be evaluated every five years, with the next evaluation to be done in the year 2000 (to be done by U.S. Army Corps of Engineers);
- Baseline estimates of plant, bird, and mammal species richness;
- Baseline estimates of bird and mammal presence or absence;
- Annual estimates of plant, bird, and mammal species richness;
- Annual weed mapping and photo surveys;
- Annual assessment endpoints for the vegetation community and wildlife populations;

293

- Anticipated or estimated impact area of any proposed project;
- Identification of any plant or wildlife species populations of interest; and
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial: Rock Creek and Antelope Springs/Apple Orchard Springs wetland complexes.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occur:

- Extant high quality wetlands decrease visibly from baseline;
- A measured or anticipated loss of high quality wetlands from the baseline amount;
- New weed species are reported for the vegetation community;
- Weed mapping and/or photo surveys indicate weed species are spreading or increasing in the vegetation community;
- Weed control assessment monitoring indicates low effectiveness of a treatment option;
- A decline in the plant, bird, or mammal species richness or densities;
- Loss or major decline of any of the predominant plant, bird, or mammal species from the vegetation community;
- Loss or major decline of any population of an identified plant species of interest or any plant or animal special-concern species; and/or
- Significant change in any of the assessment endpoints—

THEN Evaluate actions to achieve the stated goals.

294

5.4.5 Mesic Mixed Grassland Vegetation Community

Inputs:

- Baseline map of mesic mixed grasslands;
- Areas and positions of high and elevated use by wildlife as shown in *1995 Annual Wildlife Survey Report* (Kaiser-Hill, 1996);
- Baseline estimates of bird and mammal species richness;
- Baseline estimates of bird and mammal presence or absence;
- Annual estimates of bird and mammal species richness;
- Annual weed mapping and photo surveys;
- Anticipated or estimated impact area of any proposed project;
- Identification of any plant or wildlife species populations of interest; and
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial: Current RFETS geographic boundaries.
All characteristic mesic mixed grasslands within RFETS and its Buffer Zone.

Temporal: Yearly decisions from 1997 forward regarding species richness of characteristic plants, cover of noxious weed species, and bird or mammal species numbers.

Decision Statement:

IF One or more of the following occur:

- A measured or anticipated loss of mesic mixed grassland vegetation community from the baseline amount;
- New weed species are reported for the vegetation community;

- Weed mapping and/or photo surveys indicate weed species are spreading or increasing in the vegetation community;
- Weed control assessment monitoring indicates low effectiveness of a treatment option;
- A decline in the plant, bird, or mammal species richness or densities;
- Loss or major decline of any of the predominant plant, bird, or mammal species from the vegetation community;
- Loss or major decline of any population of an identified plant species of interest, or any plant or animal special-concern species; and/or
- Significant change in any of the assessment endpoints—

THEN Evaluate actions to achieve the stated goals.

5.4.6 Aquatic Community

Inputs:

- Fish species present in streams in each of the major drainages at the Site;
- Fish species present in ponds in each major drainage at the Site;
- Fish species list from Baseline Characterization (1991-1992);
- Relative abundance of species (if available);
- Map of all stream drainages on the Site; and
- Locations of all sample points.

Boundaries:

- Streams and ponds within the Site boundaries; and
- Yearly decisions from 1999 forward.

Decision Statement:

IF One of the following occurs:

- A fish kill is observed;
- A decline in fish species richness is observed; or
- Abnormalities in fish are observed—

THEN Evaluate actions to achieve the stated goals.

5.5 Design for Integrated Ecological Monitoring

5.5.1 Decision Errors

Limits on decision errors were stated by the planning team as follows:

- Reasonable expectation that monitoring will detect any change of interest listed above;
- Reasonable expectation that monitoring will not incorrectly indicate that one or more changes occurred, triggering an unnecessary evaluation of management actions;
- Reasonable expectation that monitoring will detect the presence of special-concern species and any impacts to such species; and
- Reasonable expectation that compliance with applicable regulations can be achieved.

Decision errors and their consequences are presented in Table 5-2.

297

Table 5-2
Decision Errors and Their Consequences

Decision Error	Consequences
Fail to detect one or more changes of interest that would lead to an evaluation of management actions. (This error type is of greater concern.)	Vegetation or aquatic community management approaches (e.g., weed management, limited access, limitation of disturbances) go unchanged, with the possible loss of habitat (or species) that could otherwise be conserved or protected.
Incorrectly decide one or more changes occurred, triggering an unnecessary evaluation of management actions.	Unnecessary expenditure of time and money to reevaluate vegetation community management plans that are actually working.

5.5.2 Statement of Need

The Site requires an Ecological Monitoring program that will provide data that can be used in management and conservation decisions during the Site cleanup over the next decade. In addition to data required for management and conservation decisions, the Site must remain in compliance with all applicable wildlife and wetland protective regulations. To meet this need, the proposed Site ecological program will monitor key variables over time in each of five vegetation communities. The data collected will be used to make discrete, but ongoing, determinations regarding changes in those key variables. These determinations will drive decisions regarding ecological protection and compliance decisions.

5.5.3 Monitoring Design

The design of the Ecological Monitoring program follows the development of decision rules regarding conservation and regulatory compliance at the Site. These decision rules specify the measurement and evaluation of analytical parameters for five vegetation communities and for Preble's meadow jumping mouse populations at the Site. They also specify the criteria that will help ensure regulatory compliance. These criteria, if detected for any of the variables, will trigger a reevaluation of ecological conservation actions or reevaluation of the Site project designs. These decision rules are formulated such that each can independently trigger an action. This is important since it will be fundamental to the way that evaluations are structured. Evaluations are structured to parallel the independence of decision rules.

The Ecological Monitoring program is designed to collect representative data from all sensitive and important vegetation communities at the Site to provide an integrated basis for decisions on vegetation community conservation and management, special-concern species protection, wetlands protection, and mitigation for all Site actions. The continuous data collection in representative vegetation communities across the entire Site allows ecologists to track trends in wildlife and plant populations seasonally and annually. Comparisons from year to year allow ecologists to detect changes, identify potential causes, and plan corrective strategies for changes due to Site activities rather than natural fluctuations. Availability of comprehensive data for each vegetation community type at the Site greatly aids compliance and protection evaluations and decision making for specific projects, and avoids the need for many expensive, one-time-only Site-specific studies. Ecologists are able to use data from comparable vegetation community units and extrapolate those data to similar units that may not have been monitored specifically to evaluate the potential presence of plant and animal species populations. With this knowledge available, ecologists can make more cost-effective evaluations of ecological concerns and compliance and protection decisions.

The five vegetation communities to be monitored to provide the inputs discussed above were identified on the basis of data collected and analyzed from 1991 to 1995. These baseline data were evaluated to define the communities at the Site. The most important or sensitive vegetation communities were selected for conservation monitoring. Vegetation communities were described in Section 5.3.

Key parameters to be measured and used in comparisons are presented in Table 5-3 and include:

- Species richness of plants in the vegetation community;
- Species richness of birds in the vegetation community;
- Species richness of mammals in the vegetation community;
- Presence of noxious weeds;
- Changes in vegetation communities;
- Species richness of fish in the aquatic community; and
- Preble's meadow jumping mouse populations and associated habitat characteristics in appropriate habitat.

299

Table 5-3
Parameters to be Measured vs. Vegetation Community

Vegetation Community	Measure			
	Preble's Mouse Populations and Habitat Characteristics	Noxious Weeds	Changes in Vegetation Communities	Species Richness (Plant and/or Animal)
Xeric tallgrass prairie		X	X	X
Riparian wood-land complex	X[a]	X	X	X
High quality wetlands		X	X	X
Tall upland shrubland	X[a]	X	X	X
Mesic mixed grassland		X	X	X
All other habitats		X	X	
Aquatic community				X

Note:
[a] These parameters will be measured where known Preble's meadow jumping mouse populations occur.

5.5.3.1 Vegetation Communities

To summarize, there are three separate parameters that will be evaluated. These parameters are wildlife and plant species richness, presence of noxious weeds, and changes in vegetation communities.

Species richness. Historically, the Site personnel have made a number of qualitative measurements of species richness. These measurements should continue. Changes in any of them, when quantified against the decision rule for species richness, should trigger further investigation, including an examination of field notes to offer potential explanations.

Baseline measurements for species richness in all vegetation communities will be determined using data gathered from the Buffer Zone in the years 1993 through 1996. Species richness surveys will be performed in all listed vegetation communities annually. Data collection will be performed in spring and summer, broken into two distinct data collection periods to ensure that spring ephemerals are recorded, as well as plants that mature late in the growing season.

300

Noxious Weeds. Monitoring will be performed to track the success of weed control strategies. Weed species and desirable plant species cover will be characterized in a treatment area prior to treatment. After an appropriate time period for the particular treatment option used, weed species and desirable species cover will again be assessed. Management strategies for weeds, including undesirable consequences of certain treatments, can thus be tracked, and strategies can be revised based on real-time results. Weed mapping performed in 1997 will establish baselines for these measurements. This portion of the program will be a component of the integrated weed control program for the Site.

Changes in Vegetative Communities. Photographic survey plots will be permanently established at vantage points adjacent to all vegetation communities to be monitored. The camera lens used for the photographs will be a standard size for all records made. Photographs will be taken from these survey points in summer and winter seasons in woody communities and annually in grasslands. Seasonal and annual comparisons of these photographs will be used to determine what type and amount of change has occurred within these vegetation communities over time. Should visible loss occur to a vegetation community, management and protection strategies will be reevaluated.

Acreage was calculated for each vegetation community following completion of vegetation mapping in 1996. This vegetation map serves as the 1996 baseline map against which changes will be compared. Weed mapping and comparisons will be performed annually, or more frequently as determined by current conditions.

5.5.3.2 Preble's Meadow Jumping Mouse

Preble's meadow jumping mouse populations in selected population centers will be measured annually. Population estimates will be determined through trapping in known or potential Preble's meadow jumping mouse population areas. Trapping will occur only during the May through September activity period of this hibernator. Habitat characteristics will be monitored by measuring plant species coverage (area), density, height, and canopy cover. This will be done for each major vegetative canopy strata within the habitat. Baseline conditions will be established on the basis of all monitoring through 1996.

5.5.3.3 Mammals and Birds

The measurements to be made on birds and mammals are species richness and relative abundance. These parameters, as with plant species richness, can only be assessed annually from continuous sampling due to the seasonality of species.

Resident birds and mammals, including special-concern species, and uncommon and rare birds and mammals will be counted on line transects. The numbers counted will be determined by the dimension and number of the transects, not by the total population at large on the Site. The number of transects will be determined based on available vegetation communities at the

301

discretion of the ecologists on Site. Since decision rules require that an apparent change in bird and mammal species richness or presence triggers reevaluation of conservation and management actions, a minimum sampling effort will be undertaken to count representative species at the Site in any given year. Monthly surveys will attempt to record representative species expected to occur in each vegetation community for the current season. Baseline was established in the *1995 Annual Wildlife Survey Report* (Kaiser-Hill, 1996).

Bird species analysis. Bird species richness will be measured monthly and assessed within each vegetation community for the seasons and the entire year.

Mammal species analysis. As with bird species richness, mammal species richness will be measured monthly within each vegetation community and assessed for seasons and the entire year.

5.6 Regulatory Compliance Monitoring DQOs

In addition to ecological conservation and habitat protection, specific decisions on threatened and endangered (T&E) species, state species of special concern (SSC), and migratory birds and wetlands must be considered. The initial decision to be made is whether a proposed project has potential to impact T&E and SSC species, migratory birds, or wetlands. Such projects may require mitigation actions before they are allowed to move forward. Much of the data to support these decisions will come from the data collected from monitoring each vegetation community as discussed above. This monitoring, however, does not focus on specific areas that may be affected by the footprint of a proposed project. Therefore, additional data needs may arise to support project-specific decisions in accordance with the regulatory requirements as they occur. The discussion that follows is applicable to each of the regulatory drivers. Therefore, specific data requirements and a design for sampling and analysis are not included.

Specific management goals to be supported by these efforts are:

- Protect T&E and SSC species at the Site and comply with applicable state and federal T&E species protection regulations and policies;
- Protect migratory birds at the Site and comply with applicable state and federal migratory bird protection requirements; and
- Protect Site wetlands and comply with applicable state and federal wetland protection requirements.

5.6.1 Threatened, Endangered, and Special-Concern Species

Inputs:

- Seasonal presence/absence, location, and abundance of T&E or SSC species in any area of potential impact by a proposed project;
- Seasonal timing of a proposed project;
- Presence of habitat considered suitable for T&E species;
- Biology of T&E or other species of concern (food habits, home range, habitat preference, nesting habits, etc.); and
- Information about the anticipated impacts of the proposed project.

Boundaries:

Spatial: The area potentially affected by any Site project.

Temporal: The time frame in which a proposed project could occur.
Locations of alternative project sites.
Jurisdictional policies and propriety.

Decision Statement:

IF Any T&E or SSC species, population, individual or habitat may be affected by a proposed project—

THEN Notify project personnel and suggest alternatives for modifying the project.

IF The project cannot be altered to achieve a "no effect" determination for the T&E species—

THEN Advise DOE, RFFO to conduct a Section 7 consultation with the USFWS.

IF The determination is made to proceed with the proposed project by altering it—

THEN Provide assistance to design the project to comply with regulatory requirements.

The performance of biological assessments for T&E species is not within the scope of this plan; therefore, additional required methods are not discussed here.

Limits on Decision Errors:

The decision will be based on a qualitative study of the area of potential impact, as well as existing information about the potentially impacted area or similar habitat to that which will be affected. It should be noted that any impact to any individual is of concern, not just impact to a population. Care will be taken to identify any potential impact to T&E species.

5.6.2 Migratory Birds

Inputs:

- Seasonal presence, relative abundance and location of migratory birds or their nests in areas potentially impacted by Site projects;
- Location and seasonal timing of proposed projects that might affect migratory birds; and
- Biology of potentially affected migratory bird species (food habits, home range, habitat preference, nesting habits, etc.).

Boundaries:

Spatial: The area potentially affected by Site projects.
Specific areas where migratory birds or nest locations overlap the footprint of specific proposed activity (as opposed to the area potentially affected by all possible projects).
Locations of alternative project sites.
Jurisdictional policies and propriety.

Temporal: The time frame potentially affected by Site projects.
Specific time frames where migratory birds or nest locations overlap the footprint of a specific proposed activity (as opposed to the area potentially affected by all possible projects).

Decision Statement:

IF Migratory birds, their nests, fledglings, or eggs are present in a location that may be affected by a proposed project—

THEN Notify project personnel and determine whether the project can be altered to avoid impacts.

IF Removal is required—

THEN Obtain removal permits from the USFWS and adhere to any permit limitations.

Limits on Decision Errors:

Decisions will be based on a qualitative study of the area of potential impact as well as existing information on the potentially impacted habitat. Care will be taken to identify and avoid any potential impact to migratory bird species.

5.6.3 Wetlands

Inputs:

- Presence and location of wetlands on the Site (based on 1994 U.S. Army Corps of Engineers wetland report and field verification) (U.S. Army Corps of Engineers, 1994);
- Presence and location of wetlands not mapped by the U.S. Army Corps of Engineers;
- Determination of jurisdictional wetlands presence based on U.S. Army Corps of Engineers wetland delineation manual (U.S. Army Corps of Engineers, 1989);
- Location, timing, and description of proposed projects that potentially impact wetlands; and
- Jurisdictional policies and propriety.

Boundaries:

Spatial: The area of any Site project.
Specific areas where wetlands overlap the footprint of proposed activities.
Locations of alternative project sites.

Temporal: The time frame of any Site project.

3065

Decision Statement:

IF	Any wetland may be affected by a proposed project—
THEN	Advise project personnel and seek to redesign the project to avoid wetland impacts.
IF	The project cannot be redesigned to avoid impacts—
THEN	Proceed with a wetland delineation in accordance with U.S. Army Corps of Engineers wetland delineation guidelines (U.S. Army Corps of Engineers, 1989).
IF	The delineation indicates that the wetlands is jurisdictional—
THEN	Advise DOE of the need to consult with the U.S. Army Corps of Engineers and EPA to determine the need for and amount of mitigation wetland acreage that will be required for the project.

Limits on Decision Errors:

Decisions will be based on qualitative evaluation of the area of potential impact for wetlands and jurisdictional determination of wetlands present. Wetlands determination will be governed by performance of a wetlands delineation in accordance with the U.S. Army Corps of Engineers wetlands delineation manual (U.S. Army Corps of Engineers, 1989). Care will be taken to identify and avoid any potential impact to wetlands. The results of any wetland investigations will be conducted to err on the side of protection.

5.7 References

Colorado Division of Wildlife, 1998. News Release: Commission Makes Changes to Threatened and Endangered List. Denver, Colorado, May 8.

Congressional Research Service, 1994. *Ecosystem Management: Federal Agency Activities,* Library of Congress, Washington, DC., 124p.

Kaiser-Hill Company, L.L.C., 1996. *1995 Annual Wildlife Survey Report. Natural Resource Compliance and Protection Program.* Prepared by PTI Environmental Services. Rocky Flats Environmental Technology Site, Golden, Colorado, April.

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U.S. Department of Energy, 1992a. *Draft Phase III FRI/RI Report, Appendix E, Environmental Evaluation, Rocky Flats Plant 881 Hillside Area, Operable Unit 1,* Rocky Flats Plant, Golden, Colorado, October.

U.S. Department of Energy, 1992b. *Baseline Biological Characterization of the Terrestrial and Aquatic Habitats at the Rocky Flats Plant*, Rocky Flats Plant, Golden, Colorado, September.

U.S. Department of Energy, 1994. *Policy 9-19: Erosion Control and Vegetation Stabilization, Revision 0*, Golden, Colorado, January 4.

307

Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

Soil Monitoring

September 1999

308

Table of Contents

List of Figures

6.0 SOIL MONITORING

6.1 Introduction

6.1.1 Contaminant History

Since nuclear materials were first processed at the Rocky Flats Environmental Technology Site (RFETS or the Site), the potential for dispersing contaminants into the atmosphere and onto the soils within the Industrial Area and throughout the Buffer Zone has existed due to the inherent hazards associated with handling and processing nuclear materials. Three events at the Site contributed widespread, observable radionuclide contamination of soils: the 1957 fire in Building 771, the 1969 fire in Building 776 and, most significantly, the release of contaminated cutting fluids into soils on the 903 Pad in the 1960s. The latter event culminated in the dispersion of measurable quantities of radionuclides [mostly plutonium (Pu) and americium (Am) isotopes] into the eastern Buffer Zone and off-Site areas previously identified as OU2 and OU3, respectively.

Soil "hot spots," regions of localized radionuclide contamination, are found in the Industrial Area and in some parts of the Buffer Zone. These hot spots are a result of spills, burial of contaminated drums and debris (such burial was standard operating disposal practice in the 50s and 60s), and runoff from other contaminated source areas.

Process buildings are also potential sources of contamination. However, high-efficiency particulate air (HEPA) filtration on the effluent stacks and vents of process buildings has controlled these potential emissions to the extent that this source of contamination is not considered a major contributor to surface soil contamination on and around the Site during routine operating conditions.

In addition, sediments in process-water ponds (primarily the Solar Evaporation Ponds) and surface water detention ponds (A, B, and C Series Ponds; used primarily for detention of stormwater runoff from the Industrial Area and treated sanitary waste effluent) are contaminated with radionuclides to varying degrees. These ponds hold contaminated sediments and are a potential source of contamination to subsurface soils and stream beds downstream of the ponds.

6.1.2 Existing Soil Contaminant Information

The history of spills and contaminant dispersion events at the Site is most accessible in the report commissioned by the Colorado Department of Public Health and Environment (CDPHE) entitled *Rocky Flats History - Rocky Flats Toxicologic Review and Dose Reconstruction Task 3/4 Report* (ChemRisk, 1992). Background soil contamination at the Site is primarily attributable to global fallout from atmospheric testing of nuclear weapons.

In addition, a rich database exists from which to determine the contaminant dispersion profiles at and around Rocky Flats. Surveys to determine the extent of contamination in surface soils were performed extensively in the 1970s and 1980s, and routine monitoring of surface soils was performed from 1972-1977 and 1984-1994 with limited sampling from 1978 to 1983. While such data cannot identify all areas of contamination, the results provide a good perspective on contaminants that were dispersed through larger airborne events. Limitations in survey data are related to specific hot-spots of contamination, which may exist due to burials and localized spills of contaminated materials. Many such locally contaminated areas have also been characterized during the environmental investigations of the early 90s. A discussion of soil sampling methods is discussed in *Rocky Flats Plant Final Environmental Monitoring Plan*, 1992.

The routine survey data reveal dispersed on-Site Pu 239 contaminant concentrations which range (averaging data from each location over the period of 1984 to 1994) from 11 picrocuries per gram (pCi/g) down to 0.06 pCi/g (near background level) with highest concentrations found east and east-southeast of the 903 Pad. Fence-line concentrations in the surface soil range from 5 pCi/g down to 0.24 pCi/g along the Indiana Street perimeter, again with the higher concentrations to the east and east-southeast of the 903 Pad. Along the west, north and south perimeter fences, near-background concentrations are generally observed. Soil sampling results are presented in *Rocky Flats Plant Final Environmental Monitoring Plan*, 1992 (EG&G, 1992).

6.2 Site-Wide Soil Monitoring

Inherent to the issue of contaminant dispersion in the environment are several questions:

- Are the contaminants continuing to be dispersed such that the environment is being further degraded?
- Are the contaminants that are present in the environment being redistributed in some manner that is important to the environment or public health?
- What level of environmental damage has resulted?
- Is the environment recovering from the original insult?

These questions can generally be answered only on a media-specific basis; the data quality objectives (DQOs) for monitoring to determine environmental impact depend on the sensitivity of the medium being measured and the purpose of the investigation. For example, a regulatory threshold to which soil emissions contribute, such as an air dose to the public or surface water concentration, may be quite different than the threshold for measurable impact on an animal species through ingestion from plant uptake. For this reason, soil investigations have more recently been focused on project-specific potential to impact regulatory standards.

311

As noted earlier, a routine Site-wide soil monitoring program was conducted for many years at the Site, with sampling performed by both CDPHE and Site personnel. The 11 years of data reviewed in the *1994 Annual Site Environmental Report* (Kaiser-Hill, 1995) do not indicate any changes or trends in soil contaminant levels that would be attributable to redistribution of the contaminants over the multiple-year time-scale. Should significant releases, or other events (or project requirements) at the Site suggest a need to recharacterize the generalized distribution of contaminants, routine soil monitoring could be revisited.

6.3 Project-Specific Soil Characterization Sampling

In addition to the general characterization of contamination in the environment, the Site frequently has requirements to characterize the immediate area around project activities that will disturb potentially contaminated soils. Requirements for such project-specific sampling are generally defined at the time the project is being planned, and will follow guidelines specified in the soil disturbance permitting procedures (1-B37-HSP-12.08, Excavation and Trenching and 1-F20-ER-EMR-EM.001, Environmental Approval Process for Construction/Excavation Activities) and soil sampling procedure (4-F99-ENV-OPS-FO.20), or in other less generic project plans. Many soil samples were collected in the early 1990s to characterize the contaminant dispersion around suspected burial and spill areas. These site characterization samples were used, along with the routine data, to generate a detailed contaminant dispersion map, featuring isopleths that present the contaminant dispersion profiles around the Industrial Area. Figure 6-1 is an example of these isopleths, showing Pu concentrations in this example. As with the routine samples, the general trend is for the highest concentrations to be found near and to the east and east-southeast of the 903 Pad with isolated hotspots located near other historical release areas.

Under the *Rocky Flats Cleanup Agreement* (RFCA) (DOE et al., 1996), this kind of sampling is defined through the project Proposed Action Memorandum (PAM) or an Interim Measure/Interim Remedial Action (IM/IRA) Plan, and the Field Implementation Plan (FIP) or Sampling and Analysis Plan (SAP). The contents of such plans include results of searches of historical records, identification of sampling locations and results from pre-project surveys, and specifications for sampling of soils in the project area.

6.4 Source Identification Sampling

Under RFCA, it may become appropriate to further investigate the soils in the vicinity of a surface water exceedance point or stream in order to characterize the nature of the potential contaminant sources in that area. These investigations will have spatial extent determined primarily by assuming the probable reach of contaminants that could influence the exceedance point. These investigations will otherwise be similar to the methods used to characterize soils around some project-specific activity. Soil and sediment samples are managed under procedure 4-F99-ENV-OPS-FO.23.

6.5 Outstanding Issues—Actinide Migration Study

Questions remain regarding the immediate and long-term potential for contaminated soils to disperse from the Site. These questions are being evaluated in a long-term study that is investigating actinide migration pathways and characteristics. These Actinide Migration Studies may result in the identification of additional soil data needed to facilitate the investigation. Such data needs, while not expected to result in a routine soil monitoring program, may result in short-term, more project-specific soil sampling. In the long term, the results of the study may point to long-range monitoring strategies for determining the efficacy of clean-up activities or to other parameters that must be characterized more routinely.

6.6 References

ChemRisk, 1992, *Rocky Flats History - Rocky Flats Toxicologic Review and Dose Reconstruction Task 3/4 Report* commissioned by the Colorado Department of Public Health and Environment.

EG&G, 1992. *Rocky Flats Plant Final Environmental Monitoring Plan.* Golden, Colorado.

Kaiser-Hill Company, L.L.C., 1995. *1994 Annual Site Environmental Report.* Golden, Colorado.

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313

Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

Interaction Between Media

September 1999

315

Table of Contents

Page

List of Tables

Page

316

7.0 INTERACTIONS BETWEEN MEDIA

7.1 Overview

Some monitoring is performed to characterize interactions between the various environmental media. Possible interactions are presented in Table 7-1, which represents a conceptual model of integrated monitoring at Rocky Flats Environmental Technology Site (RFETS or the Site). Some significant interactions that require decision making and data are presented below.

Table 7-1
Interactions Between Media, Significance at RFETS, and Monitoring to Evaluate Interactions

Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
Surface Water to Ecology	Potentially significant; surface water flow and contamination could impact local ecology. However, the local ecology has remained healthy during a variety of climatic and flow conditions.	Data from existing Site-wide surface water monitoring may be used to assess potential ecological impacts. The ecological monitoring program is also designed to detect ecological changes and assess general ecological health. In addition, project-specific evaluations are conducted to assess potential impacts.
Surface Water to Groundwater	Not significant; groundwater recharge from surface water is not significant.	No monitoring is necessary to characterize or assess groundwater impacts.
Surface Water to Air	Not significant; surface water quality will not significantly impact air quality (i.e., cause exceedances of air quality standards).	Any significant impacts on air or water quality will be detected by existing DOE, CDPHE, and project-specific monitoring.
Surface Water to Soil	Potentially significant; water in drainages and ponds will not significantly increase contaminant concentrations in soil; however, runoff could spread contaminants on surface soils and increase sediment concentrations.	Soil monitoring is conducted to determine the impacts of surface water runoff and the extent of required soil removal before, during, and after individual remediation projects. Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded.
Groundwater to Surface Water	Significant; most of the Site groundwater flows into Site surface water drainages.	Existing surface water monitoring will detect any impacts from groundwater. Data from Site-wide groundwater monitoring (Site-wide and project-specific) is also used to assess and predict potential surface water impacts.

317

Table 7-1
(continued)

Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
Groundwater to Ecology	Potentially significant; contaminated groundwater could indirectly impact ecological resources, as well as reduce groundwater flow.	Data from existing Site-wide groundwater monitoring may be used to assess and predict potential ecological impacts. The ecological monitoring program is also designed to detect ecological changes.
Groundwater to Air	Not significant; groundwater will not directly affect air quality.	Existing air quality monitoring will detect air quality degradation, and existing groundwater monitoring will detect groundwater contamination that could impact surface water quality.
Groundwater to Soil	Not significant; groundwater contaminants appear in surface water but are not likely to contaminate surface soils.	Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded.
Air to Soil	Potentially significant; point source and fugitive emission sources could deposit contaminants on soil.	Soil monitoring is conducted to determine the impacts of air emissions and disposition and the extent of required soil removal before, during, and after individual remediation projects. Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded. Also, any significant impacts on air quality will be detected by existing DOE, CDPHE, and project monitoring.
Air to Ecology	Potentially significant; point source and fugitive emissions could deposit contaminants on ecological resources.	The ecological monitoring program is designed to detect ecological changes. Also, any significant impacts on air quality will be detected by existing DOE, CDPHE, and project-specific monitoring.
Air to Surface Water	Potentially significant; point source and fugitive emission sources could degrade surface water quality.	Surface water monitoring (Site-wide and project-specific) will detect increases in contaminant concentrations. Also, any significant impacts on air quality will be detected by existing DOE, CDPHE, and project-specific air monitoring.

318

Table 7-1
(continued)

Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
Air to Groundwater	Not significant; contaminants in air will not directly impact groundwater quality.	Groundwater monitoring will track groundwater contamination, and air quality monitoring (Site-wide and project-specific) will detect degradation of air quality that could impact other media.
Soil to Surface Water	Significant; contaminants in soils are transported to surface water via runoff and surface water quality is degraded.	Site-wide and project-specific surface water monitoring will detect increases in contaminant concentrations. Soil monitoring is also conducted to determine the impacts of runoff and the extent of required soil removal before, during, and after individual remediation projects. Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded.
Soil to Ecology	Could be significant; contaminated soils could adversely impact local ecology.	The ecological monitoring program is designed to detect ecological changes. Results of the actinide migration studies also will be used to determine whether existing soil monitoring needs to be modified or expanded.
Soil to Air	Significant; contaminants in surface soil are resuspended and air quality is affected.	Any significant impacts on air quality will be detected by existing DOE, CDPHE, and project-specific monitoring. Results of the actinide migration studies also will be used to determine whether existing soil monitoring needs to be modified or expanded.
Soil to Groundwater	Significant; contaminants migrate from surface and subsurface soils to groundwater via percolation.	The existing groundwater well network is designed to detect increases in contaminant concentrations in groundwater. Results of the actinide migration studies also will be used to determine whether existing soil monitoring needs to be modified or expanded.

Notes:
CDPHE = Colorado Department of Public Health and Environment
DOE = Department of Energy
RFETS = Rocky Flats Environmental Technology Site

7.2 Water and Ecological Health

As indicated in Table 7-1, there are interactions between surface water, groundwater, and the flora and fauna of the Site. Concerns have been expressed that changes in flow into and out of the Site could impact significant habitat and species of concern both on Site and downstream (e.g., the Preble's meadow jumping mouse on Site, and whooping cranes in Nebraska). For example, aggregate mining activities at the west-end of the Site may alter surface water flowing onto the Site and could impact species of concern on Site and downstream. In fact, water is one of the key abiotic components structuring some of the significant habitats. The Department of Energy, Rocky Flats Field Office (DOE, RFFO) could be held responsible for these impacts.

Site-specific relationships between water availability and ecological health are not known; therefore, it is not known what type of data are actually required. Additional data, currently uncollected, could be required (e.g., accurate information on purchased water, data on exfiltration and infiltration of underground pipes, and data on alluvial flow through the Buffer Zone habitats of concern).

The following preliminary decision rules have been proposed:

Preliminary Secondary Data Uses Could Include:

- Determining the impact of mining on Rock Creek water quality and availability;
- Interpreting potential causes of declines in any of the valued habitats on Site;
- Supporting water management planning and Water Right issues;
- Evaluating cumulative impacts of all actions (on and off Site);
- Validating any predicted impacts of a selected alternative on downstream resources; and
- Supporting Site biological assessments and U.S. Fish and Wildlife Service (USFWS) biological opinions.

Table 7-2
Buffer Zone Flow Monitoring Stations

Station Identifiers	Locations	Monitoring in Addition to Flow
GS01	Woman Creek/Indiana Street	RFCA and possible nutrient load monitoring; precipitation
GS02	Mower Reservoir/Indiana Street	
GS03	Walnut Creek/Indiana Street	RFCA and possible nutrient load monitoring; precipitation
GS04	Rock Creek at Highway 128	Precipitation
GS05	North Woman Creek at west boundary	Precipitation
GS06	South Woman Creek at west boundary	--
SW134	Rock Creek at west boundary (Gravel Pit)	(4 samples per year quarterly)
GS16	Antelope Springs	
SW118	Above Portal 3, north side of road	RFCA Source Location

Notes:

IA = Industrial Area
IM/IRA = Interim Measures/Interim Remedial Action
NPDES = National Pollutant Discharge Elimination System
RFCA = *Rocky Flats Cleanup Agreement* (DOE et al., 1996)
RMRS = Rocky Mountain Remediation Services, L.L.C.
SID = South Interceptor Ditch

Inputs:

- Drainage flow;
- Water level measurements; and
- Stream gain or loss.

Preliminary Boundaries Include:

Spatial: All surface waters entering and leaving the Site in the Rock Creek, Walnut, and Woman Creek drainages.

Temporal: Seasonal and yearly determinations of total water availability and basic water quality.

Preliminary Decision Statement:

IF	The seasonal average or yearly average water availability or quality entering Rock Creek, Walnut Creek, or Women Creek drainages diminishes below baseline due to off-Site activities—
THEN	The Site will notify Jefferson County and the USFWS to determine what actions, if any, should be taken to restore availability and/or quality to historical levels.
IF	Activities occurring within Site boundaries result in a depletion of the seasonal or yearly average natural flow greater than the historic baseline, or at rates that are determined to have a negative impact on downstream habitats or individual species—
THEN	The Site will determine what management actions should be taken to ameliorate this problem.
IF	Significant changes to alluvial groundwater availability in a wetlands habitat are determined—
THEN	Notify parties of potential impacts to the wetlands habitat and continue groundwater and ecological monitoring.
IF	A proposed action could adversely affect a listed species or its critical habitat—
THEN	The Site will enter into formal consultation with the USFWS.

Preliminary Acceptable Decision Errors Include:

- Confidence that Significant Events are Physically Sampled and Representative:
  - — Flow will be continually monitored; seasonal composite samples will be taken to evaluate basic water chemistry. An effort will be made to gather a sample representative of conditions during the season.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - — The function of this monitoring is to provide a watershed-level measure of water availability and quality to serve as an early warning that habitats reliant on these waters may be adversely impacted if changes continue. The Site is more concerned with failing to detect a decrease in water availability or quality over historical levels than mistakenly determining

that a decrease has occurred. The precise change over time that is of concern has not been established because the water requirements of the habitats are not fully understood. Therefore, no attempt has been made to establish quantitative limits on decision errors or to generate a statistical design.

— The integrated monitoring working group will continue to address water and ecology monitoring integration. The group needs to determine how to effectively use the Buffer Zone flow data or eliminate that monitoring altogether. The group also needs to determine if it would be cost-effective to collect additional data and how those data could be used to assess impacts on ecological health.

7.3 References

U.S. Department of Energy, Colorado Department of Health and Environment, and U.S. Environmental Protection Agency, 1996. *Final Rocky Flats Cleanup Agreement*, July.

323\323

NOTICE

All drawings located at the end of the document.

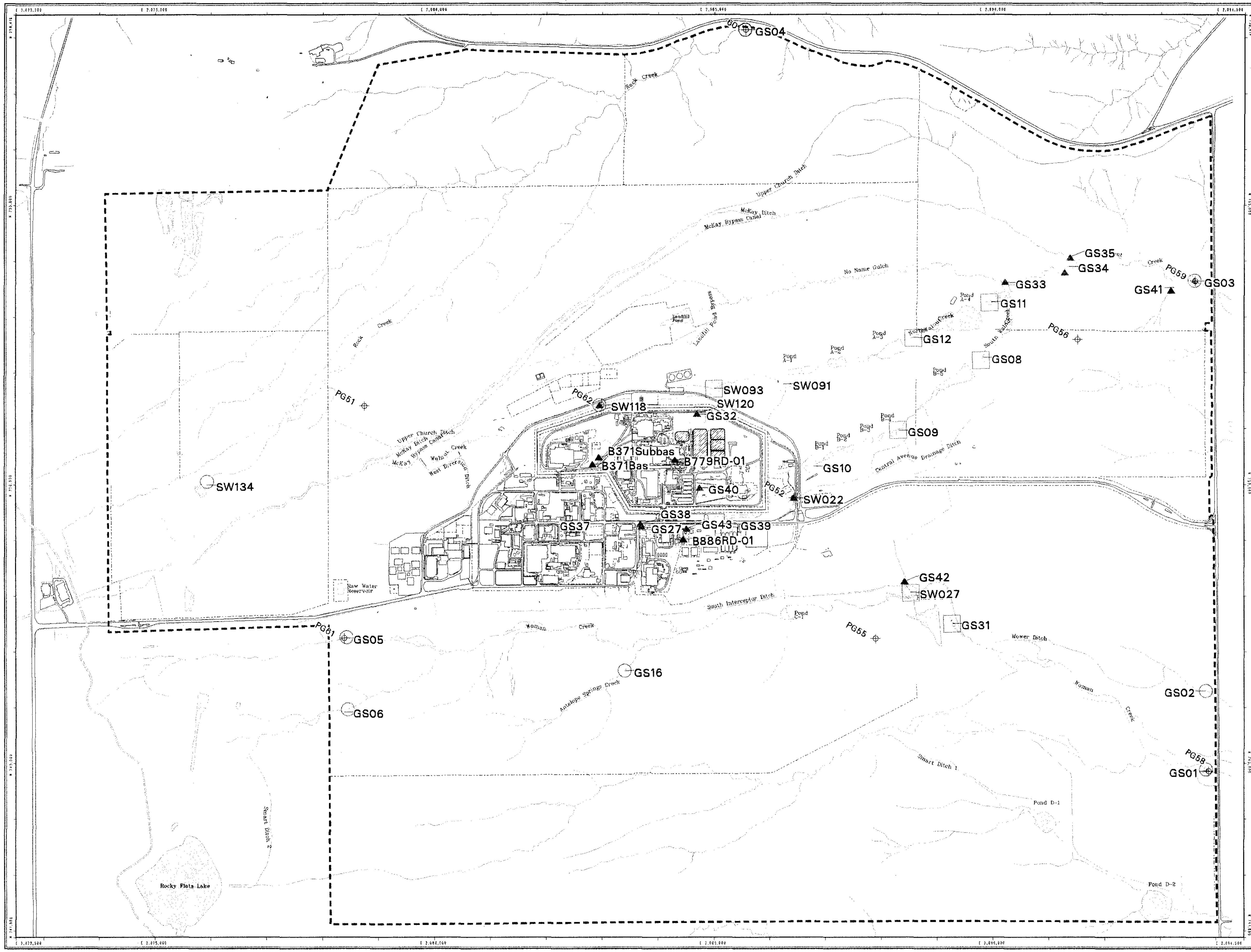

Figure 2-4

RFETS Integrated Monitoring Plan

Surface Water Features with Sample and Monitoring Locations

EXPLANATION

Precipitation Gage

Monitoring Location Objective*

- Buffer Zone Hydrologic
- New Source Detection
- Point of Compliance
- Point of Evaluation
- Source Location
- Ad Hoc
- Performance
- IDLH**

Standard Map Features

- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Rocky Flats boundary
- Paved roads

DATA SOURCE: Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy

Rocky Flats Environmental Technology Site

Rocky Mountain Remediation Services, L.L.C.
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

MAP ID: 99-0372

August 19, 1999

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42

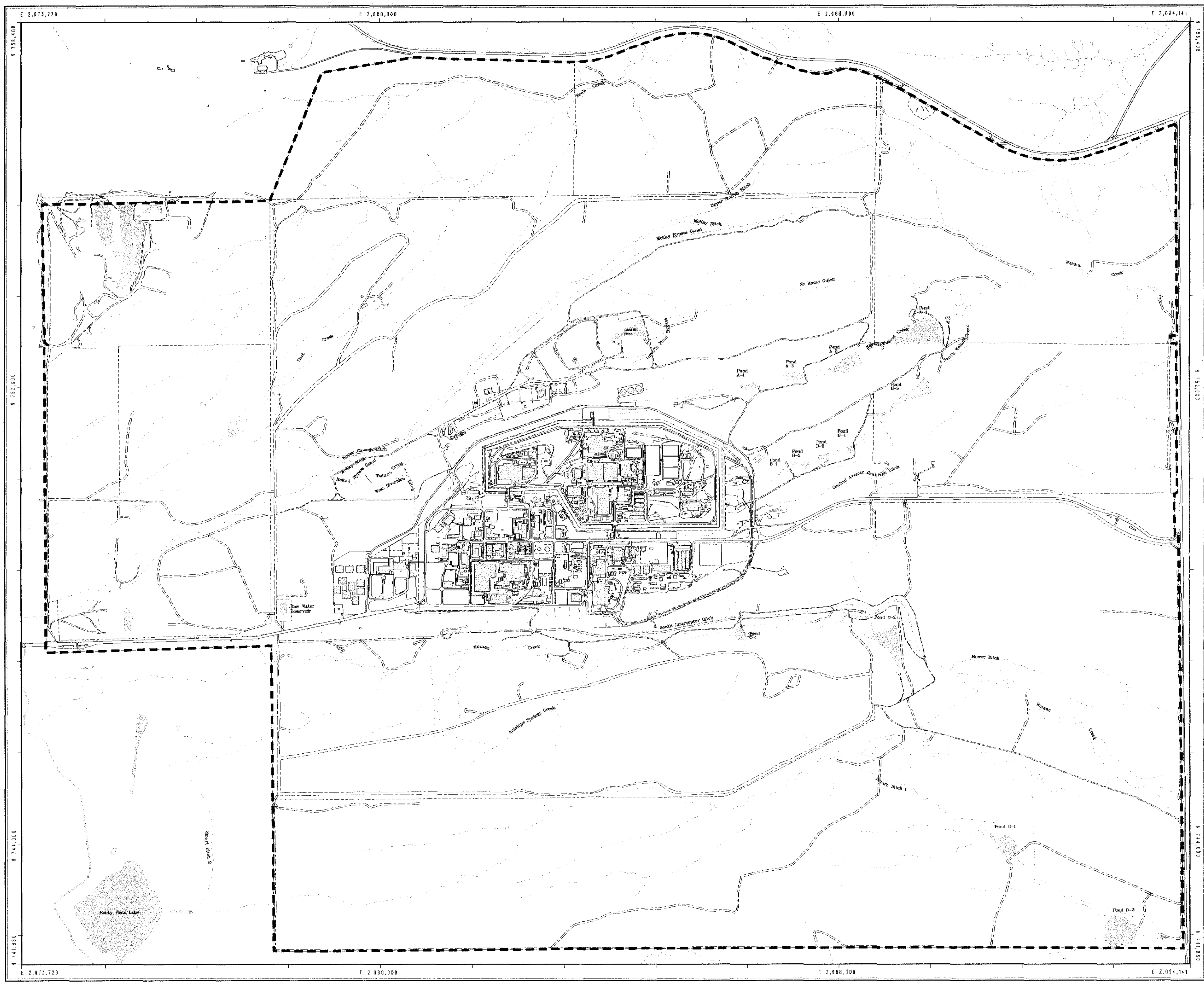

Figure 3-1

Detention Ponds, Ditches, Effluent Watercourses, and Creeks at RFETS

EXPLANATION

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE: Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

N

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

RMRS Rocky Mountain Remediation Services, L.L.C.
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

MAP ID: 97-0063 August 10, 1999

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133

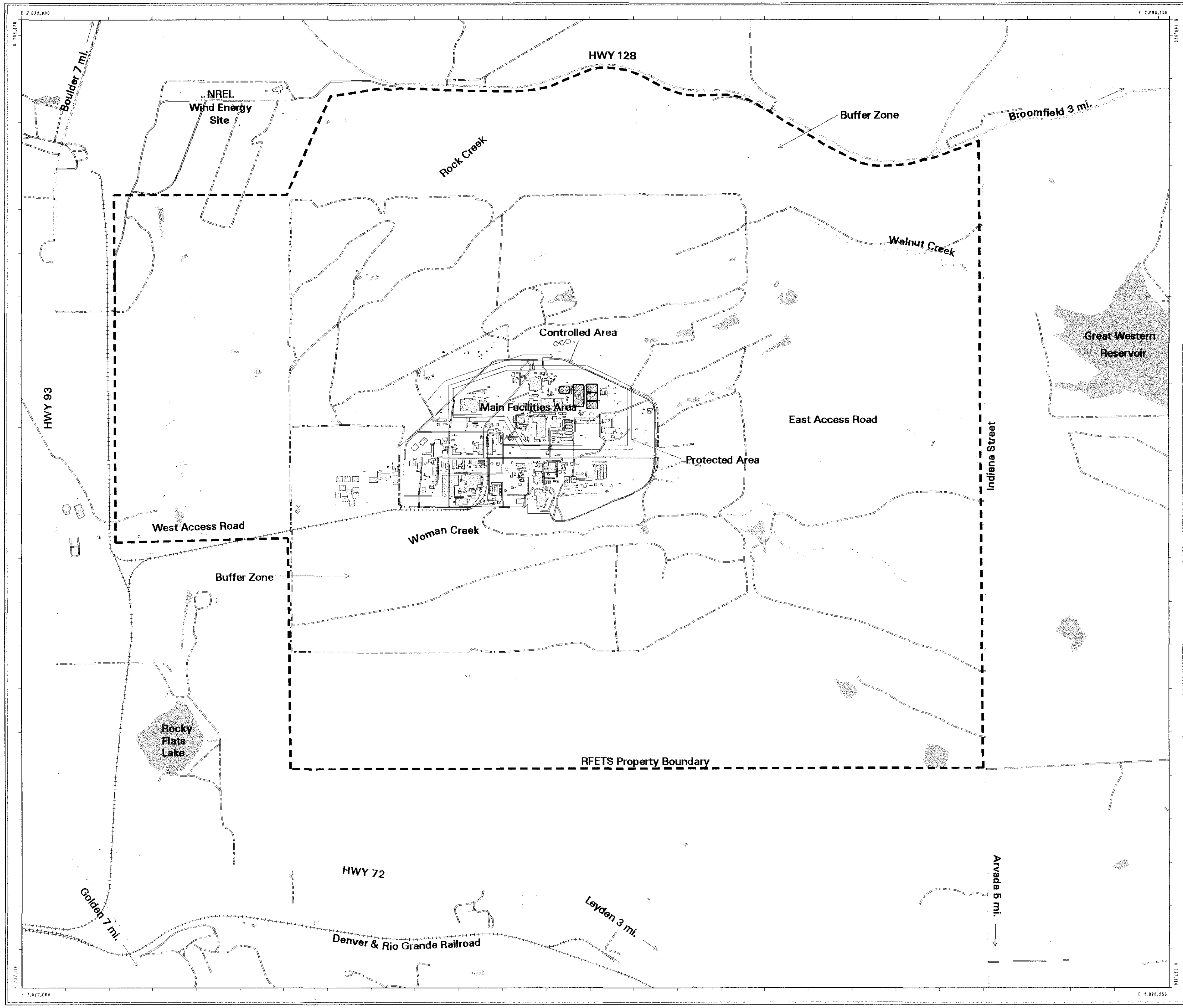

Figure A-2

Rocky Flats Environmental Technology Site Map

EXPLANATION

Standard Map Features

- Buildings
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Heavy duty paved roads
- Medium duty paved roads
- Light duty paved roads
- Dirt roads
- Railroads

DATA SOURCE: Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Scale = 1 : 28720
1 inch represents approximately 2393 feet

700 0 1400 2800ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
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MAP ID: 97-0063 September 07, 1999

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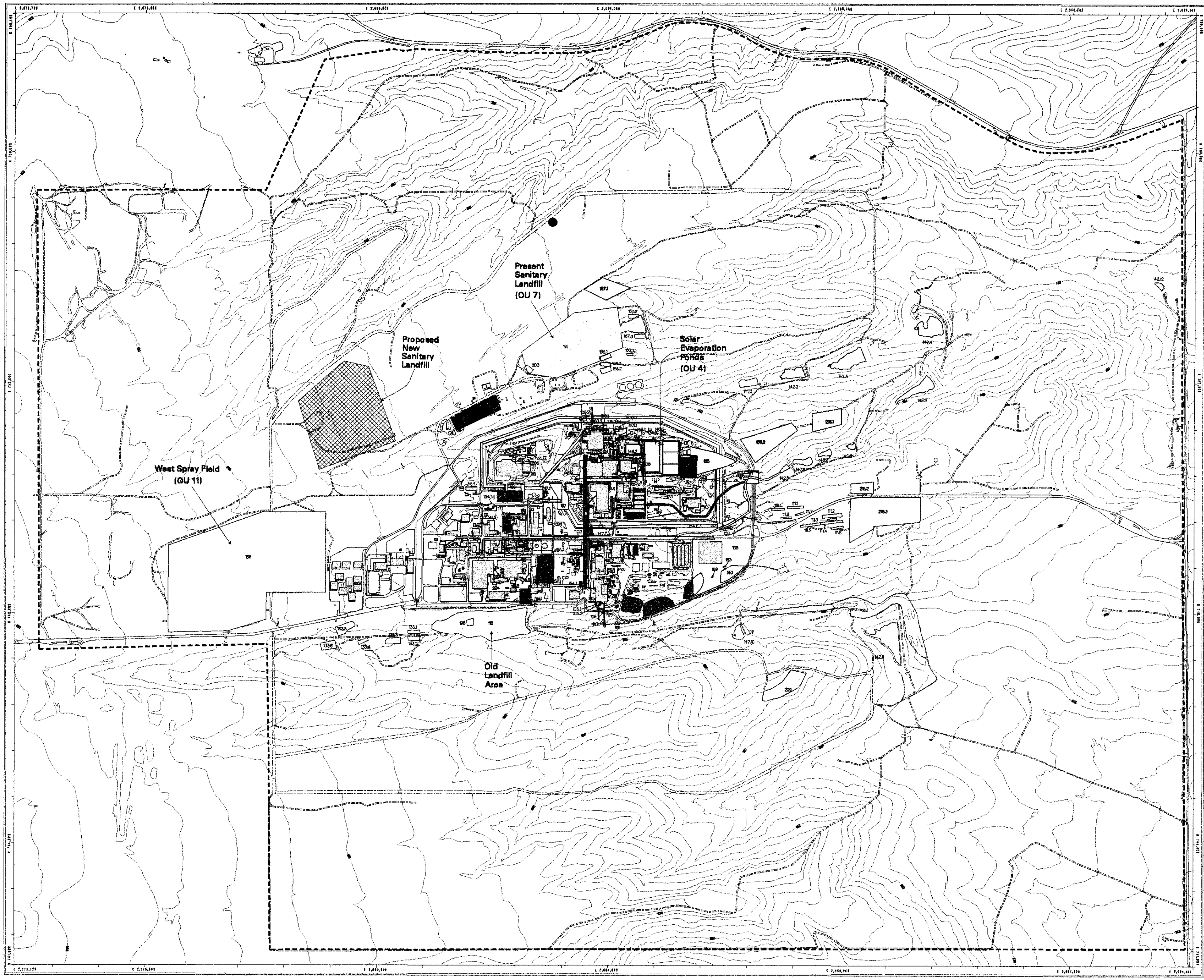

Figure A-3

Individual Hazardous Substance Sites by Operable Unit

EXPLANATION

- Operable Unit 1
- Operable Unit 2
- Operable Unit 4
- Operable Unit 5
- Operable Unit 6
- Operable Unit 7
- Operable Unit 8
- Operable Unit 9
- Operable Unit 10
- Operable Unit 11
- Operable Unit 12
- Operable Unit 13
- Operable Unit 14
- Operable Unit 15
- Operable Unit 16

Standard Map Features

- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Contours (20' Intervals)
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE: Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 5/95

Scale = 1 : 21330
1 inch represents approximately 1778 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
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MAP ID: 99-372

August 16, 1999

NT_Svr w:/projects/fy99/99-0372/oushd-nt.aml

198

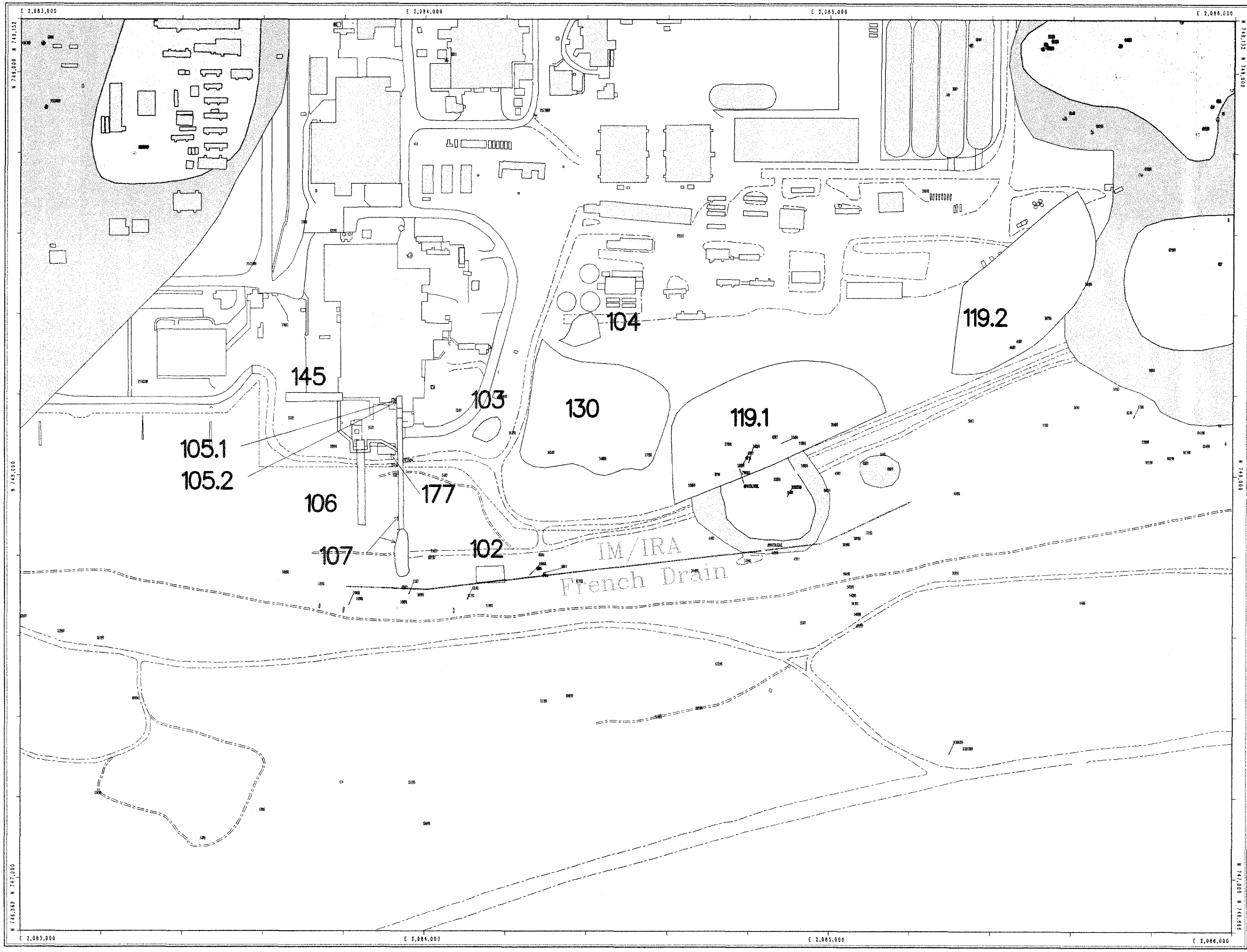

Figure D-1

Individual Hazardous Substance Sites of OU 1, 881 Hillside Area

EXPLANATION

Groundwater Monitoring Well Locations

Individual Hazardous Substance Sites

Composite VOC Groundwater Plume (100 X MCL)

Composite VOC Groundwater Plume (concentration equal to MCL)

Standard Map Features

Buildings

Lakes and ponds

Streams, ditches, or other drainage features

Fences

Rocky Flats boundary

Paved roads

Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/95

N

Scale = 1 : 2920
1 inch represents approximately 243 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: 99-0372

August 17, 1999

NT_Svr w:/projects/fy99/99-0372/ou1a_nt.aml

230

Figure D-2

Individual Hazardous Substance Sites of OU 2, 903 Pad, Mound, East Trenches

EXPLANATION

- Groundwater Monitoring Well Locations
- Individual Hazardous Substance Sites
- Composite VOC Groundwater Plume (100 X MCL)
- Composite VOC Groundwater Plume (concentration equal to MCL)
- 100 x Nitrate Standard (1000 mg/l)
- Nitrate Standard (10 mg/l)

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Rocky Flats boundary
- Paved roads
- Dirt roads

Scale = 1 : 4870
1 inch represents approximately 406 feet

100 0 200 400ft

State Plane Coordinate Projection
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MAP ID: 99-0372

August 17, 1999

NT_Svr w:/projects/fy99/99-0372/ou2a_nt.aml

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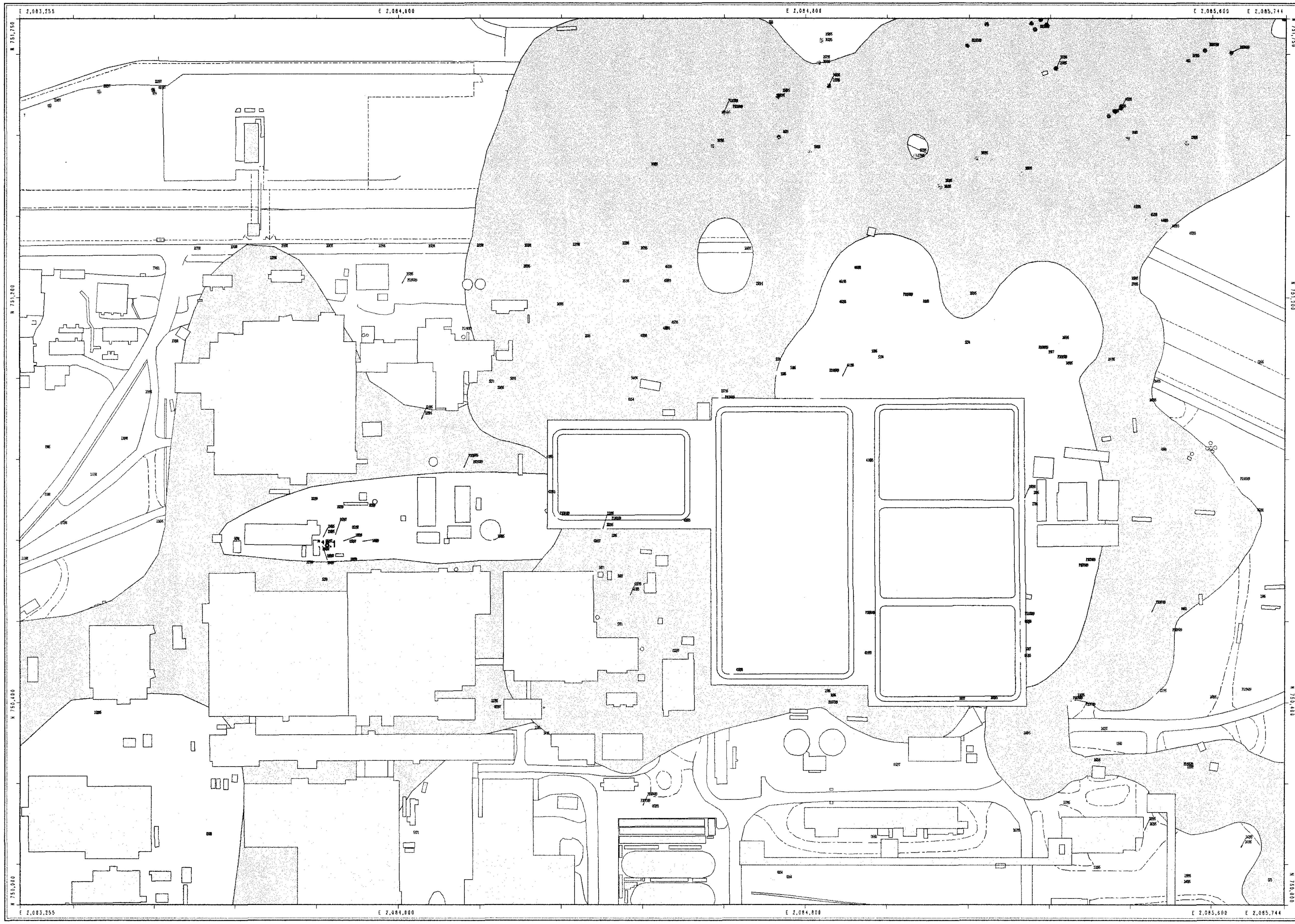

Figure D-3

Individual Hazardous Substance Sites of OU 4, Solar Evaporation Ponds and IHSS 118.1

EXPLANATION

- Groundwater Monitoring Well Locations
- Individual Hazardous Substance Sites
- Composite VOC Groundwater Plume (100 X MCL)
- Composite VOC Groundwater Plume (concentration equal to MCL)
- 100 x Nitrate Standard (1000 mg/l)
- Nitrate Standard (10 mg/l)

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

Scale = 1 : 2500
1 inch represents approximately 208 feet

50 0 100 200ft

State Plane Coordinate Projection
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MAP ID: 99-0000

August 18, 1999

335

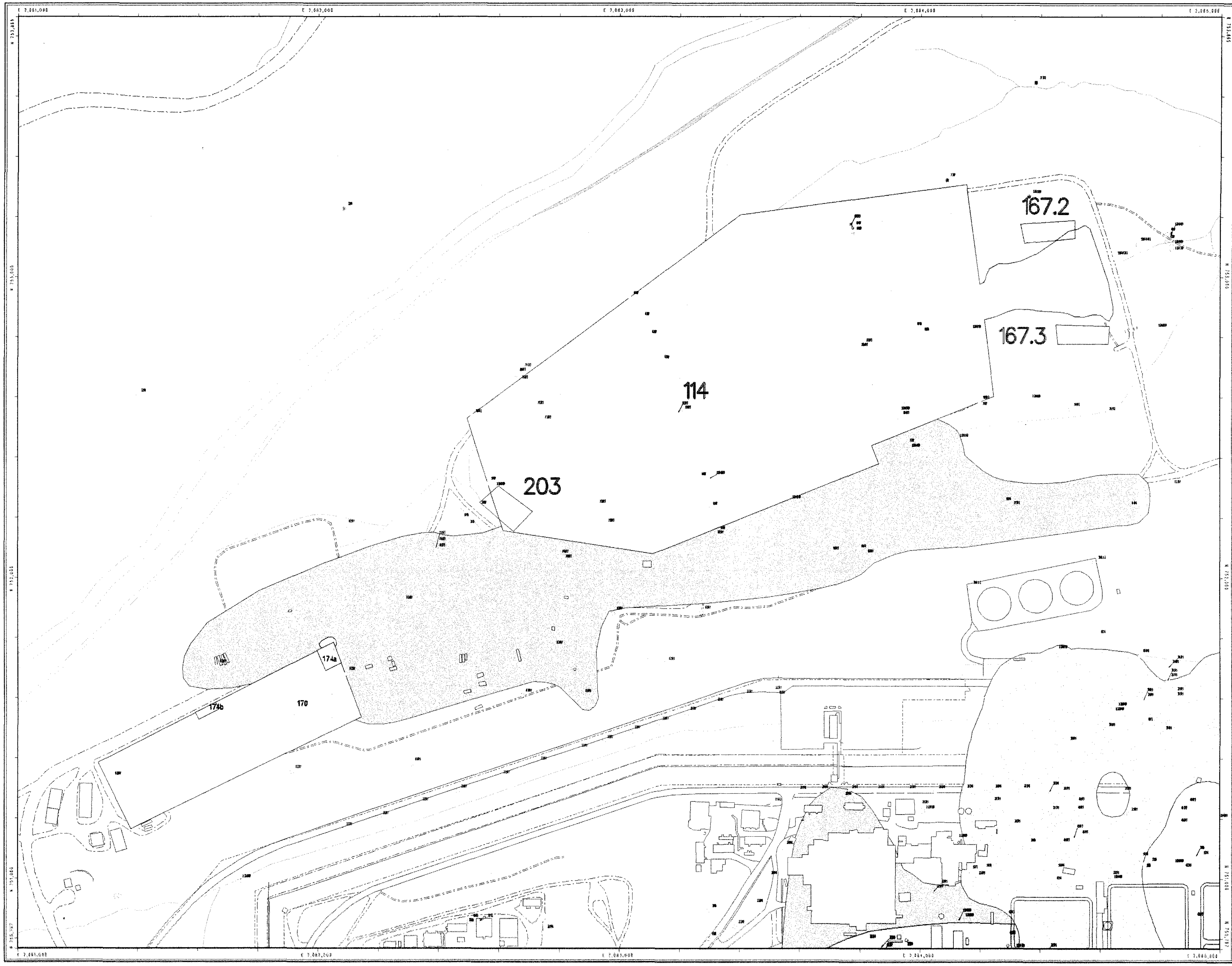

Figure D-4

Individual Hazardous Substance Sites of OU 7, Present Sanitary Landfill and IHSSs 170, 174a & 174b

EXPLANATION

- Groundwater Monitoring Well Locations
- Individual Hazardous Substance Sites
- Composite VOC Groundwater Plume (100 X MCL)
- Composite VOC Groundwater Plume (concentration equal to MCL)
- 100 x Nitrate Standard (1000 mg/l)
- Nitrate Standard (10 mg/l)

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE: Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Scale = 1 : 3830
1 inch represents approximately 319 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
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MAP ID: 99-0372 August 18, 1999

NT Svr w:/projects/fy99/99-0372/ou7a_nt.aml

339

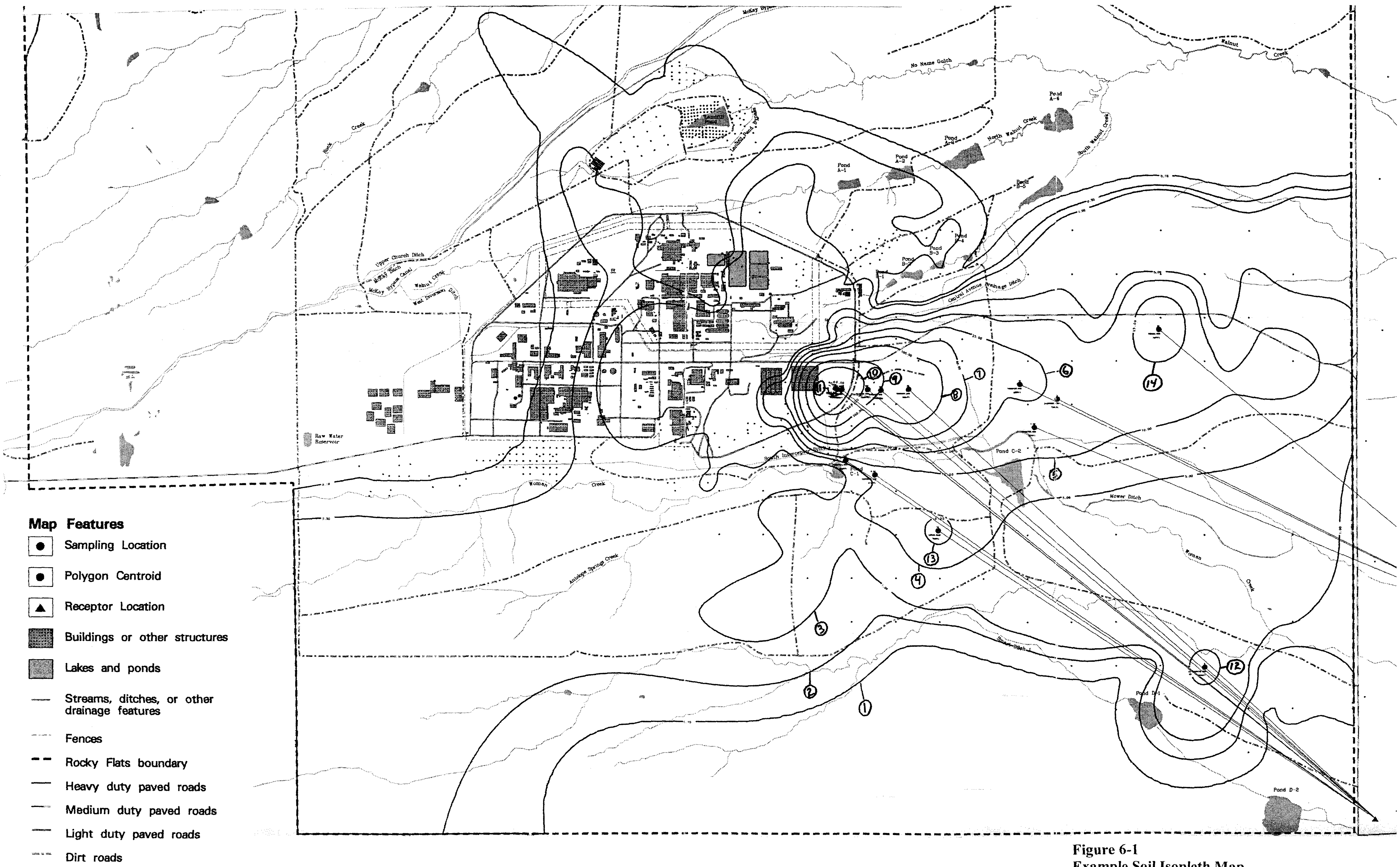

Figure 6-1
Example Soil Isopleth Map -
Pu-239/240 Concentrations of Surface Soil Samples